CONDITION OF COMMERCIAL HIGH-EFFICIENCY FILTERS UPON RECEIPT OR INSTALLATION

MYRON D. THAXTER
Lawrence Radiation Laboratory, University of California, Berkeley, Calif.

ABSTRACT

AEC-type high-efficiency filters have recently been received with media breaks. A survey under AEC auspices at other sites shows that our experience is not unique.

Filter bypassing may also be due to other factors such as gasket failures or installation errors.

* * * * *

The quality of fabrication of commercial filters has come under study at Lawrence Radiation Laboratory, Berkeley, within the past year. One shipment was inspected visually; media rips necessitated 100% rejection. Two subsequent replacement shipments from the same supplier were 100% and 80% rejected, respectively. Similar rejections were noted at the Livermore site. Some of the defects observed are shown in Figs. 1 through 4.

Several features make it difficult to evaluate filters visually: (a) less than 10% of the media of these filters is visible; (b) some of the high-efficiency filters now being offered are assembled in such a manner that visual examination is impossible; (c) even if all the media could be inspected by eye, the efficiency specification of 99.96% is far more rigorous than can be perceived by eye.

These observations, though distressing, would not in the larger view be serious were they the troubles of but one user. The problem, however, was brought to the attention of the AEC, which conducted a survey of several other contractors (reported by another speaker), and in general it was found that the experience at Lawrence Radiation Laboratory is not unique. This problem, then, warrants further consideration.

Even if proper DOP testing equipment and personnel were available at users' sites we should not forget that testing upon receipt is expensive and an unwarranted duplication of the manufacturer's test procedure.

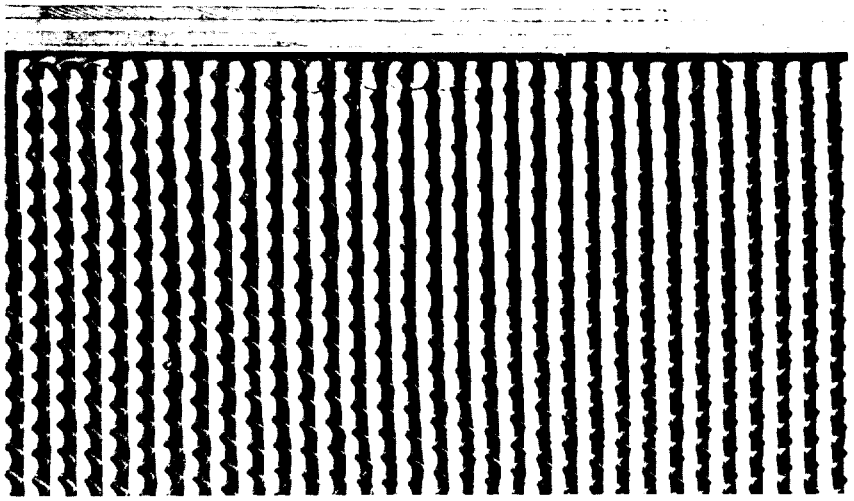


Fig. 1—Commercial high-efficiency filter with glass media and kraft separators, showing transverse media break.

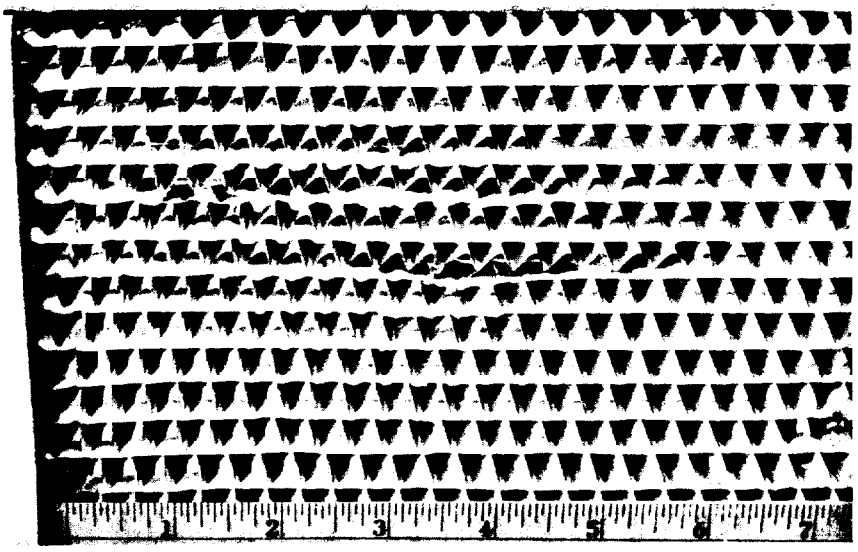


Fig. 2—Commercial high-efficiency filter with glass media and aluminum separators, showing pleat-edge media break.

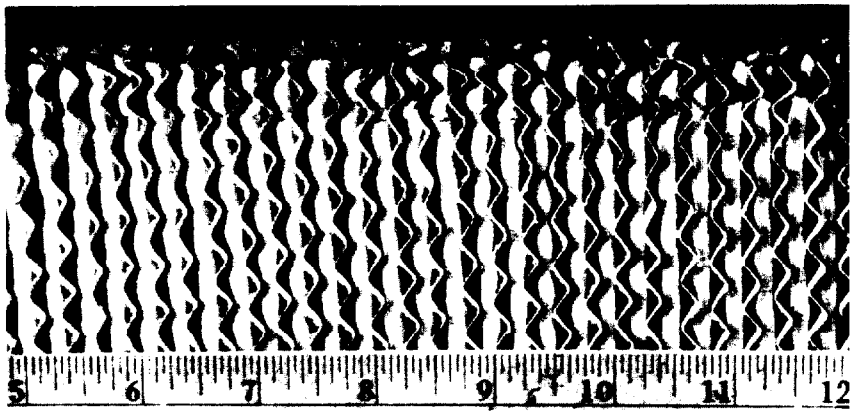


Fig. 3—Commercial high-efficiency filter with glass paper media and asbestos separators, showing transverse media breaks.

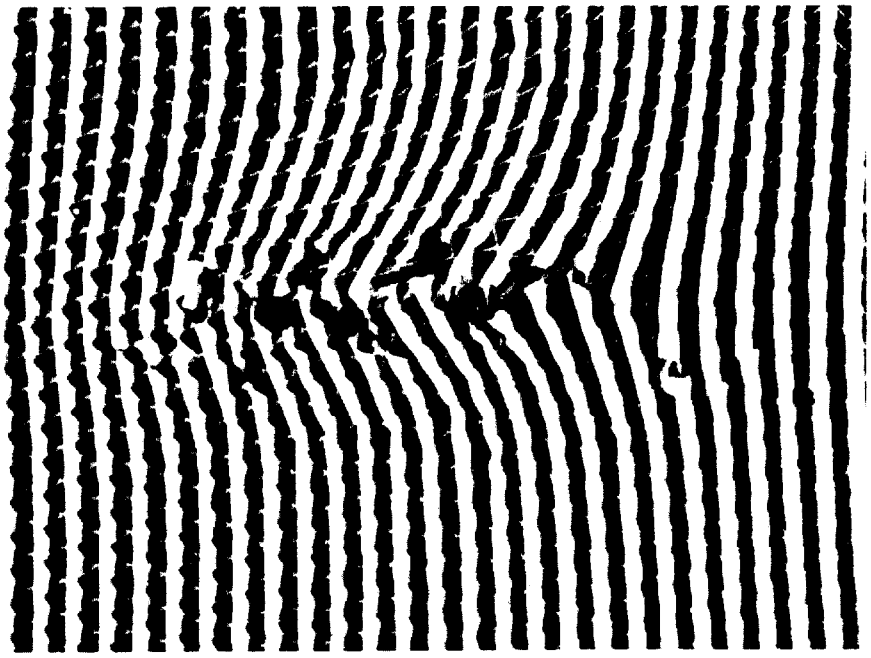


Fig. 4—Commercial high-efficiency filter with glass paper media and kraft separators, showing damage on receipt (external shipping carton undamaged).

Furthermore, acceptability tests on receipt do not assure the performance for which such filters are purchased--to wit, as installed in the duct system. It has been shown that inattention to details in fabrication and inspection of filterbank hardware, in assembly bolt pressures, and in other such minutiae can result in actual leakage around the filter and consequent pollution downstream. One weak item is the multipieced gasket on the filter face, frequently a butt-joint layup of low integrity.

A possible factor in as-installed performance--one which has not yet been evaluated--is the skill and care employed in installation. There is the possibility of substantial differences, at various laboratories, in the abilities of contractors' employees and in the local conditions of accessibility, radiation exposure, need for protective clothing, and dexterity required.

No solution is proposed here. Our purpose has been to state a real problem and invite further study leading to possible solutions. Meanwhile we had better sample our off-gas stacks continuously and carefully.

FILTER RATING AND TESTING PROGRAM

HUMPHREY GILBERT
United States Atomic Energy Commission, Washington, D. C.
and
GEORGE J. HURWITZ
Army Chemical Center, Maryland

Mr. George J. Hurwitz and I will present you some facts and some conclusions which are not necessarily the most palatable that could be talked about. Nevertheless, the atomic energy program has a problem, I should say, a real problem, affecting its air cleaning operations. We shall endeavor to be constructive.

Those of you who attended the last Air Cleaning Seminar at Harvard University in June 1957 may recall that one of the manufacturers of high efficiency particulate filters alleged that at least one of the other two manufacturers of these filters was using a DOP penetrometer which needed calibration. He inferred that, as a result, we were getting filters which did not meet the specifications for penetration and resistance, in other words, for true high efficiency.

After considering those remarks and having obtained information which seemed to bear out the allegation, we decided to verify sample filters of all three manufacturers. We also decided that the most impartial way to do this was to test random samples from filter stocks of atomic energy plants. Twelve 1000-cfm. filters were subsequently shipped to the Army Chemical Center at Edgewood, Maryland, to be tested on the Chemical Corps

DOP penetrometers, which are regarded as the most reliable to be found for this work. At the same time, each of the three filter manufacturers was invited to send samples of his own, and these were also tested and the results returned for their respective information.

When we opened the cartons containing these random samples from atomic energy stocks, and the cartons clearly had not been opened from the time the filters had been manufactured and packaged, we were appalled at what we found.

I would like Mr. George J. Hurwitz of the Quality Assurance Technical Agency, Army Chemical Center, to take over and describe the filters which were in these cartons. It was through Mr. Hurwitz' cooperation that we arranged the tests and he supervised the examinations from beginning to end. Mr. Hurwitz.

Mr. G. Hurwitz

Thank you Mr. Gilbert. Before going into the details of the testing program, let me say for the USA CmlC Quality Assurance Technical Agency that cooperating with the U. S. Atomic Energy Commission in this program has been a pleasant and instructive experience. It has been gratifying to be able to share with another Government service our capability in developing and fabricating test equipment and testing filters for both aerosols and toxic agents. As the sole source for this equipment we fully realize that the lives and health of many may rest on our ability to develop test equipment which can be depended upon for accuracy and reproducibility of results.

We have prepared a series of sixteen slides showing the damage observed when cartons containing the filters were opened at the Army Chemical Center. We did not inspect all the filters in detail; only those which gave erratic or high penetration readings. I believe that had these filters been subjected to the degree of inspection performed on Chemical Corps filters by one of our expert inspectors, several more filters would have been rejected for such defects as poor workmanship, missing or incorrectly applied adhesive, contamination or failure to meet the rough handling test.

We had been asked whether the damage observed could have been sustained during transportation so that a claim could properly be placed against the

shipper. In all honesty we had to reply that there was no way of saying definitely that this was the case. Inspection of the cartons did not indicate rough handling or abuse. In fact, the cartons were in good enough condition to be used for returning the filters to their original sources. This we do know: three filters, received at a later date, had been inspected prior to shipment and these arrived in good condition.

The filters may bave been damaged during transportation or handling in the storage area; certainly, the shipping carton can stand redesign. However, damage can result from lack of proper control during the manufacturing process; filters which are cut too long and forced into the frame; aged or brittle cement, or one which has too high a coefficient of expansion, so that, on setting up it contracts and tears the filter. I have a photograph which illustrates such a case. Damage may also result from excessively tight packing of the pleats which causes the fluted separators to cut into the filter material. Excessively loose packing will allow undesirable movements of the separators.

I mentioned rough handling. It may be of interest to you to know that Chemical Corps filters are subjected to a rough handling test in the vertical position by being vibrated at a frequency of 200 cycles per minute with a 1 inch amplitude for fifteen minutes. If the filters pass this test, they should withstand normal transportation and handling.

Another point to be cleared up is the testing requirements. Whereas it is quite possible for a filter containing small punctures to meet resistance and penetration requirements, and this will be illustrated by a slide, this nevertheless is not an acceptable filter. All tests were conducted on a Chemical Corps E18 Penetrometer and Resistance Indicator at a flow rate of 1000 cfm and a DOP particle size of 0.3 microns.

The list of invitees to this seminar apparently did not include any of the manufacturers of the filters tested; nevertheless, test data must be considered proprietary information. Slides will be shown but test results will be cited without reference to the original source of the samples.

Slides 1 and 2 show a filter with pleats so badly broken that the penetration reading was 54%. Another filter containing similar breaks gave an even higher penetration reading.

Slides 3 and 4 illustrate another filter with damaged pleats. Penetration readings were .30% and .18%. The reason for the difference is that filters were tested from each side; on damaged filters, good reproducibility is the exception rather than the rule.

Slides 5 and 6 illustrate lesser damage; penetration readings were .072%, .094%, and.095%. Corresponding resistance readings were .87", .95", and .94".

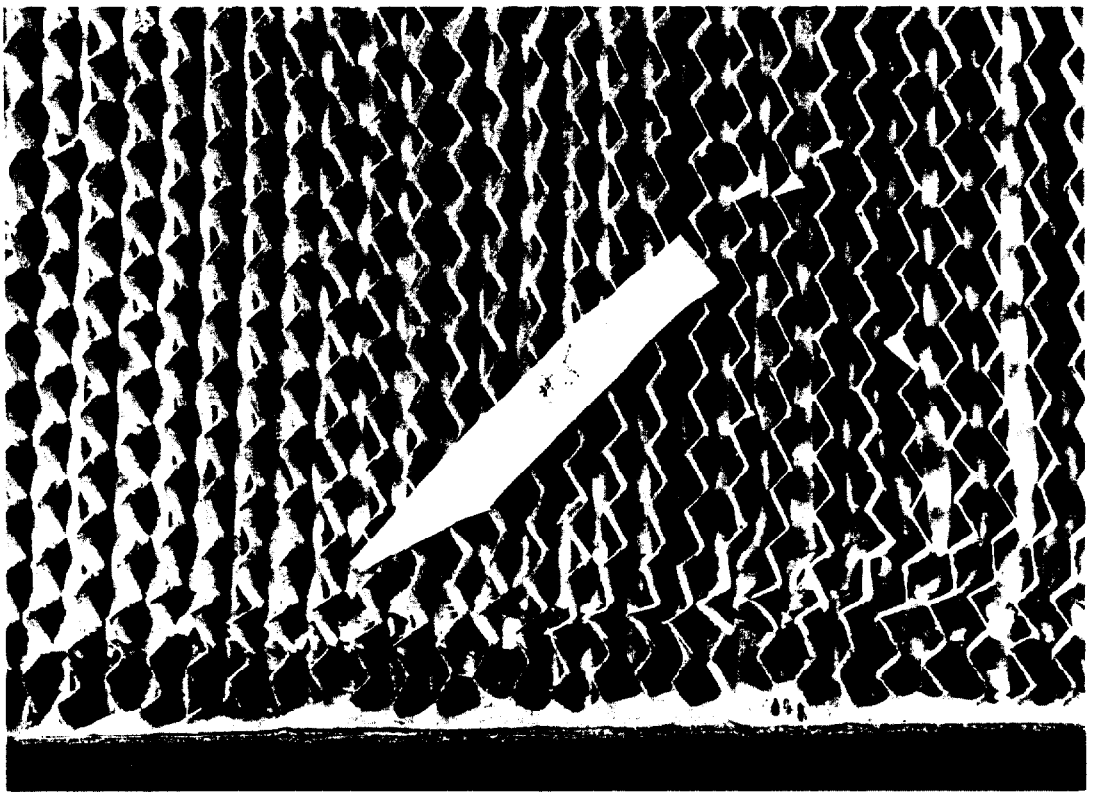
Slides 7, 8, and 9 illustrate damage of the same magnitude with penetration readings .066% and .090%. Corresponding resistance readings were .81" and .96". The distortion of the pleats indicates that the filter was oversize and forced into the frameduring assembly.

Slides 10 and 11 depict damage along the side of the filter and to a lesser degree on the bottom. Penetration readings were .32% and .40%. Resistance was .84" and .92".

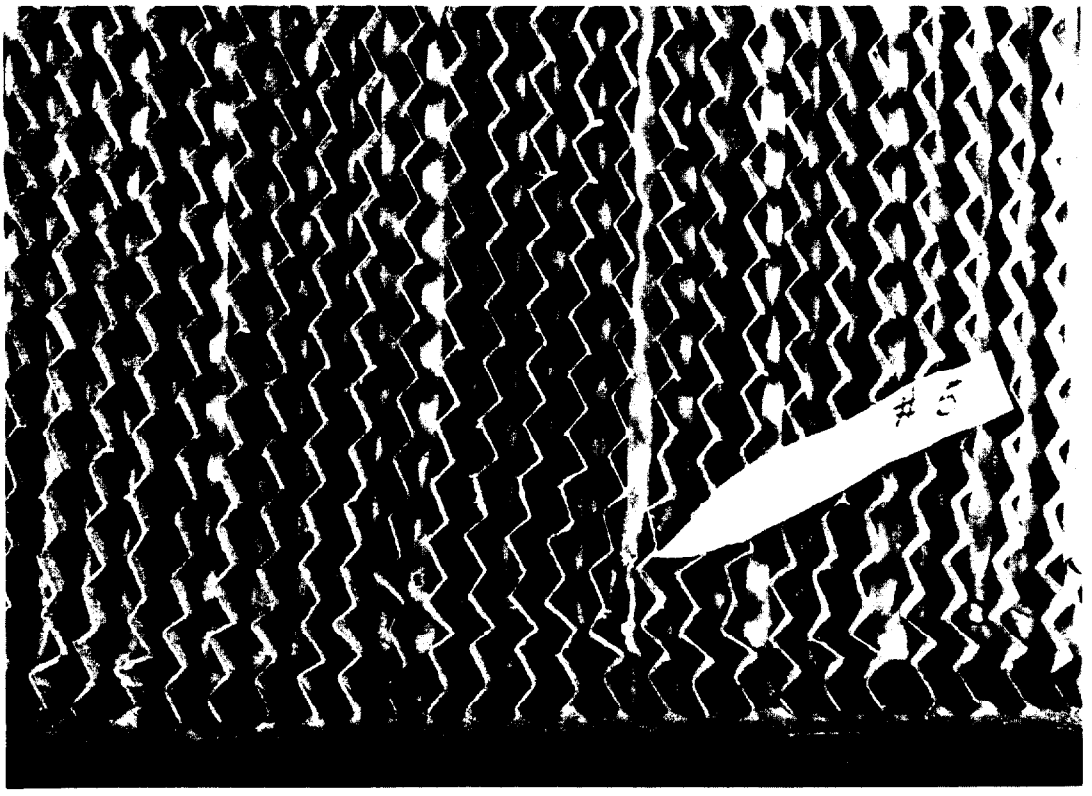
Slides 12, 13, and 14 illustrate a series of breaks along the top and bottom. Penetration readings were .046%, .12%, and .083%. Corresponding resistance readings were .76", .94", and..84".

Slides 15 and 16 illustrate a damaged filter which did meet specification test requirements. Penetration readings were .048% and .039%. Corresponding resistance readings were .74" and .88".

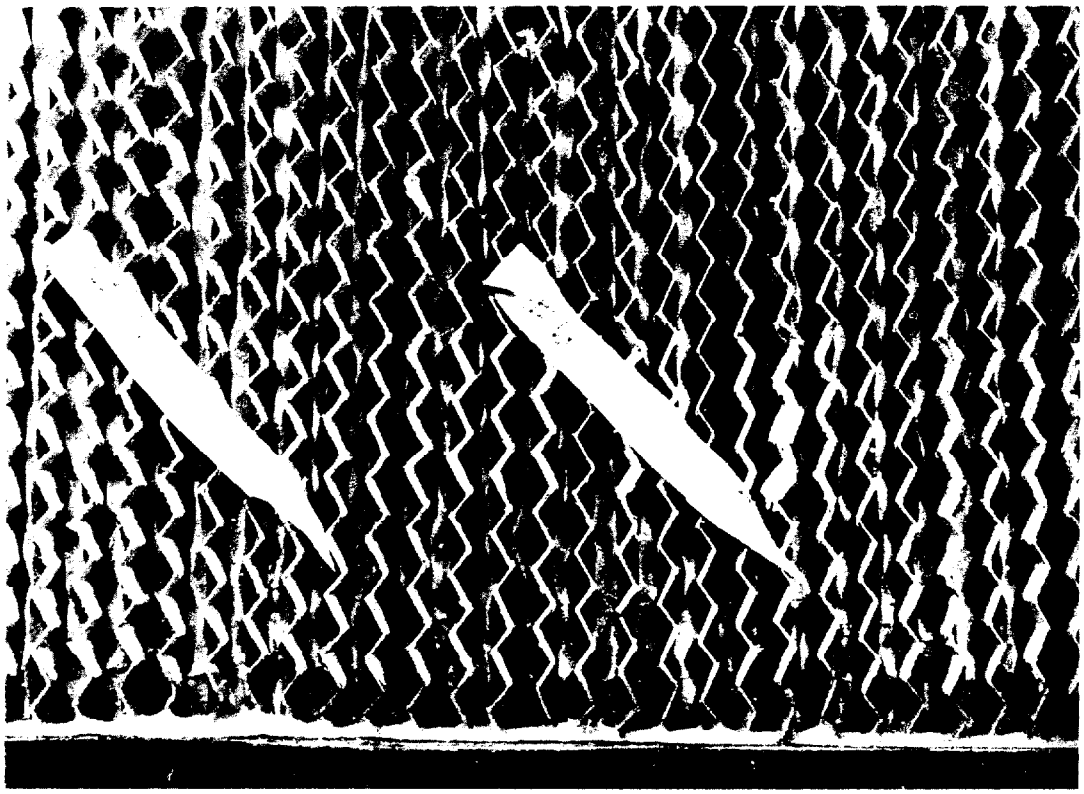
Comparisons may not be in order since the items are not identical, however as a point of information permit me to cite some acceptance inspection results on filters produced for the Chemical Corps by one of its contractors. The filters were produced from a paper asbestos medium with corrugated paper liners instead of the glass fiber asbestos medium and separators of the same material which characterize AEC filters. Frames were aluminum instead of treated plywood. Each filter was inspected in accordance with specification requirements for visual defects as well as the penetration, resistance and rough handling tests. (Text continued on p. 173)



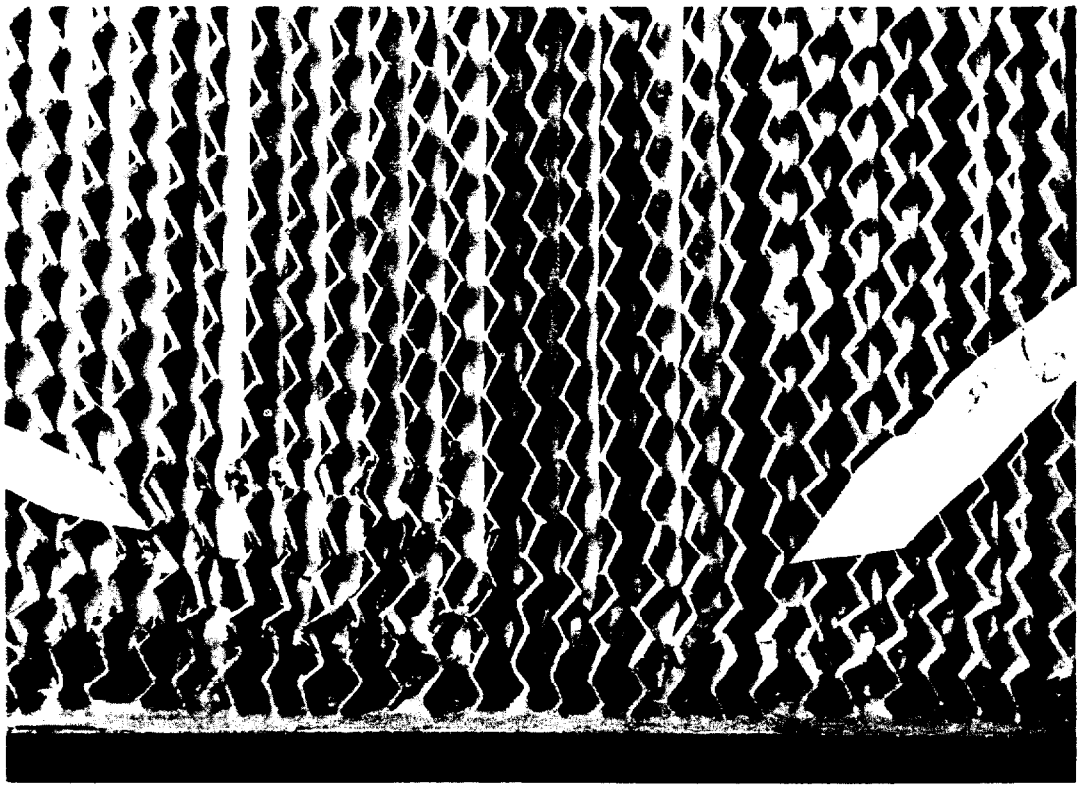
Slide 1



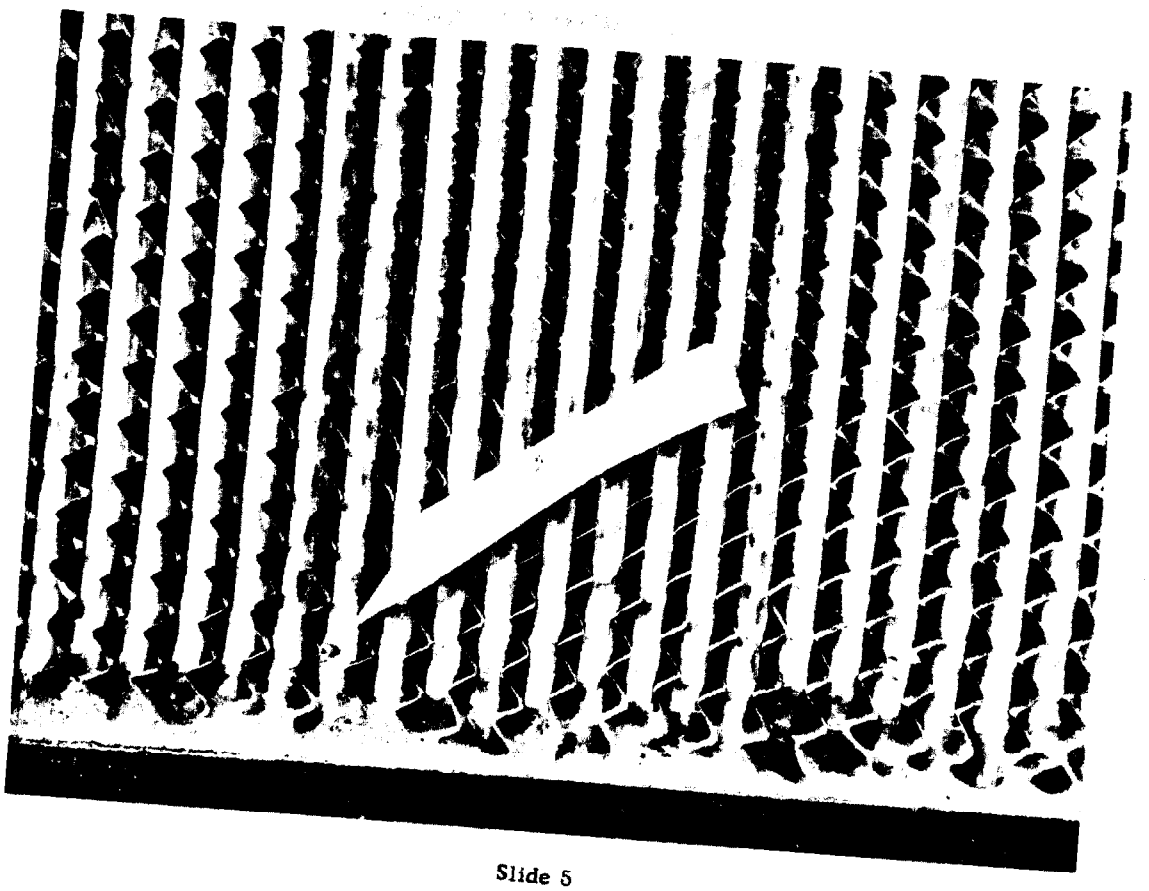
Slide 2



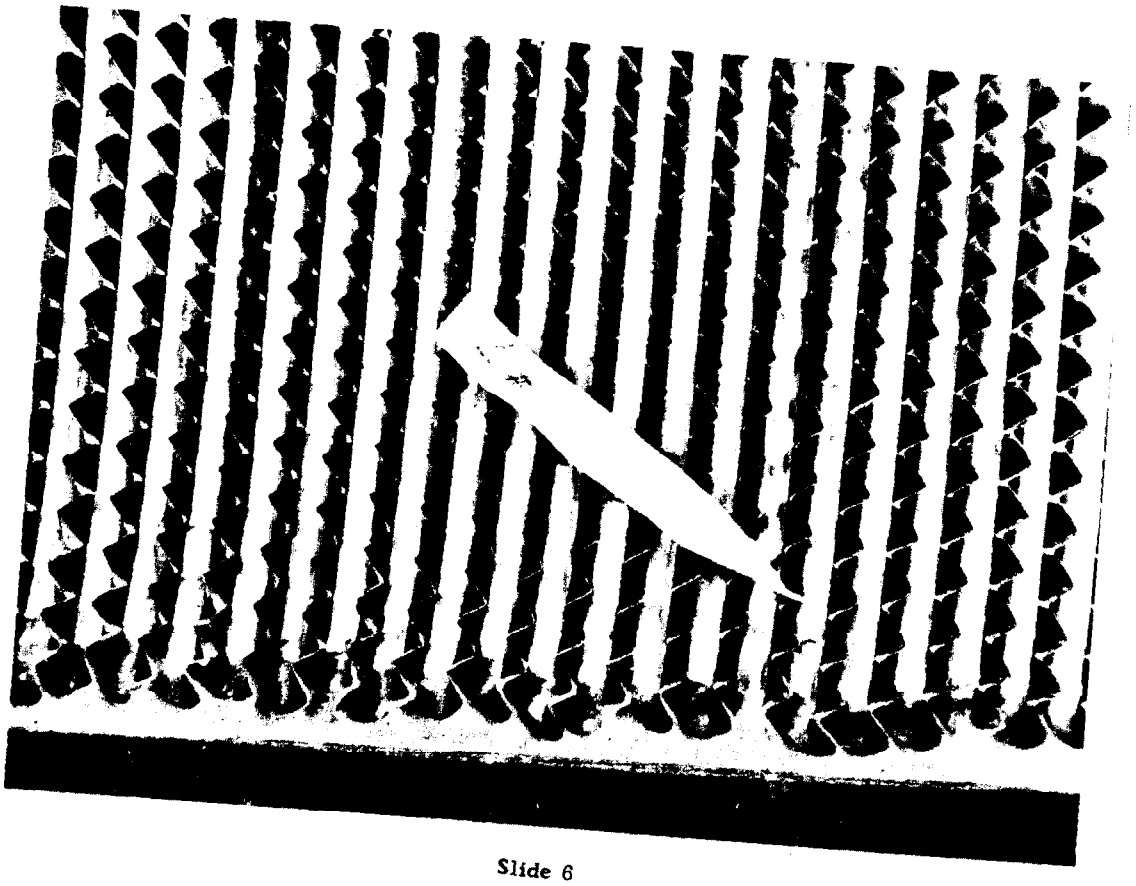
Slide 3



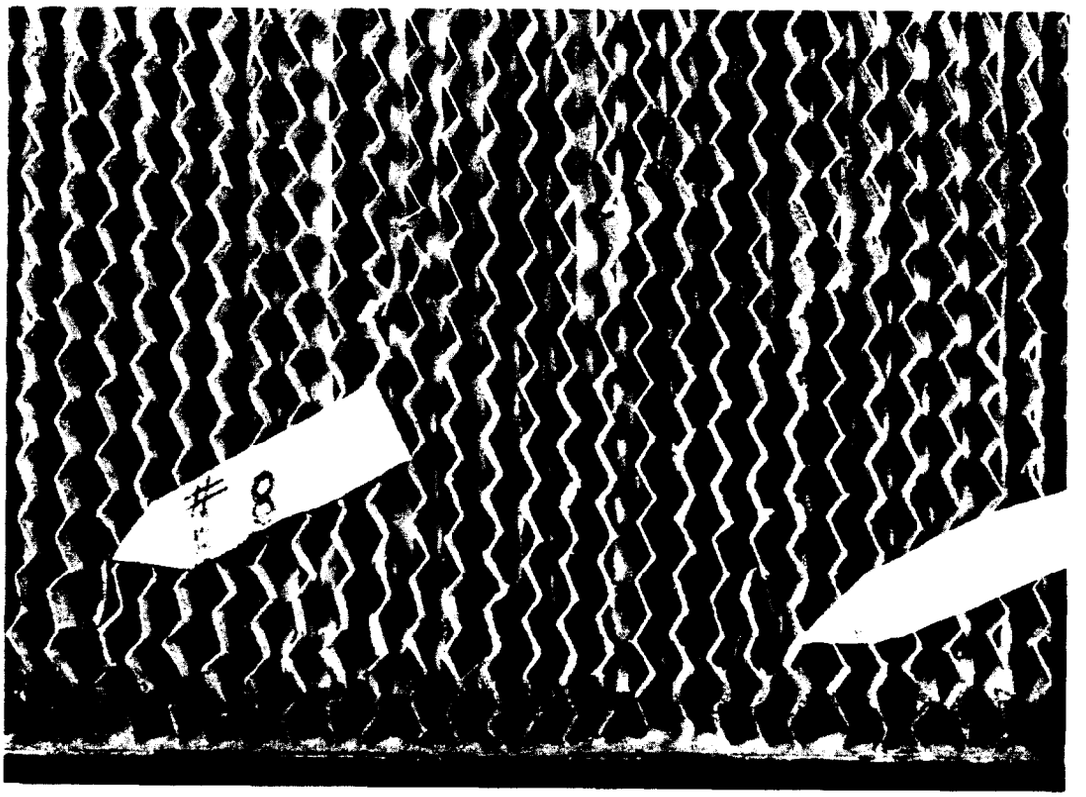
Slide 4



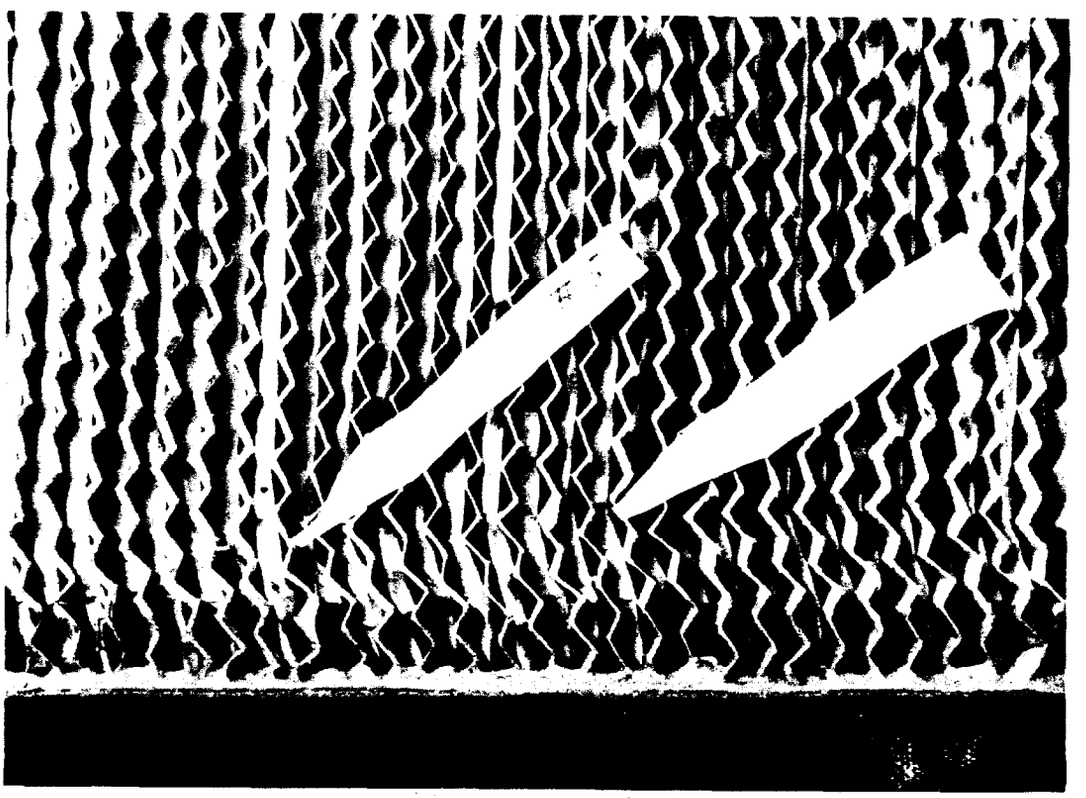
Slide 5



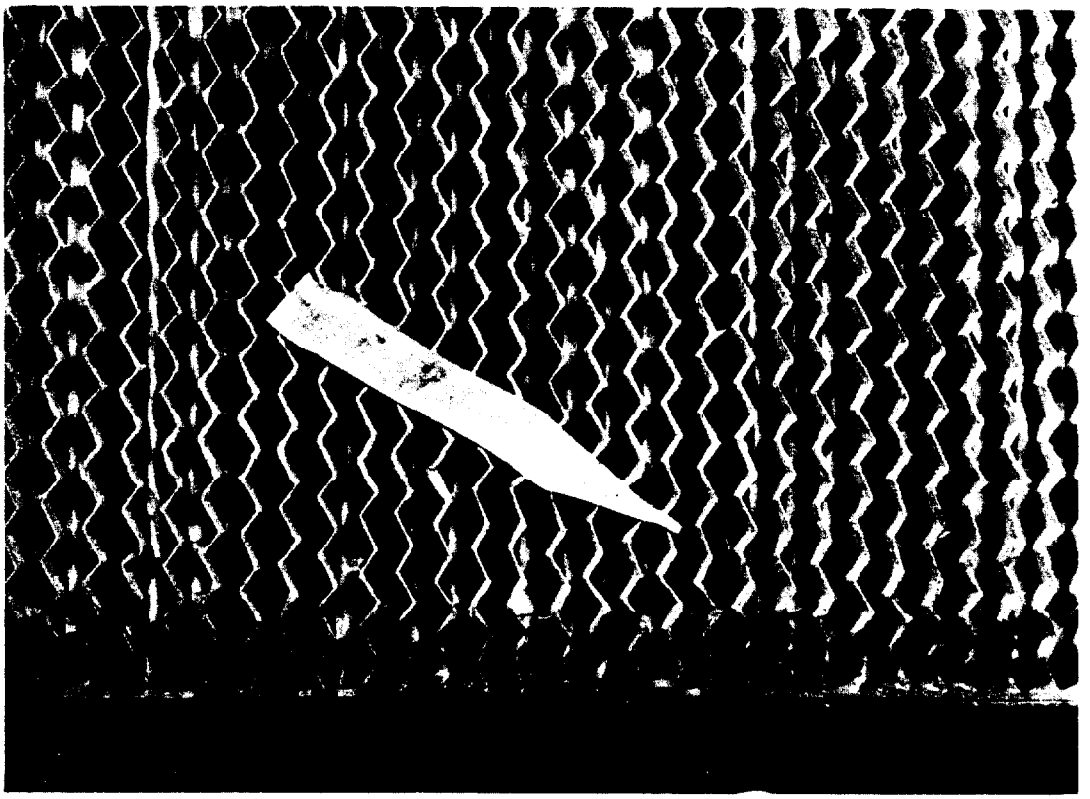
Slide 6



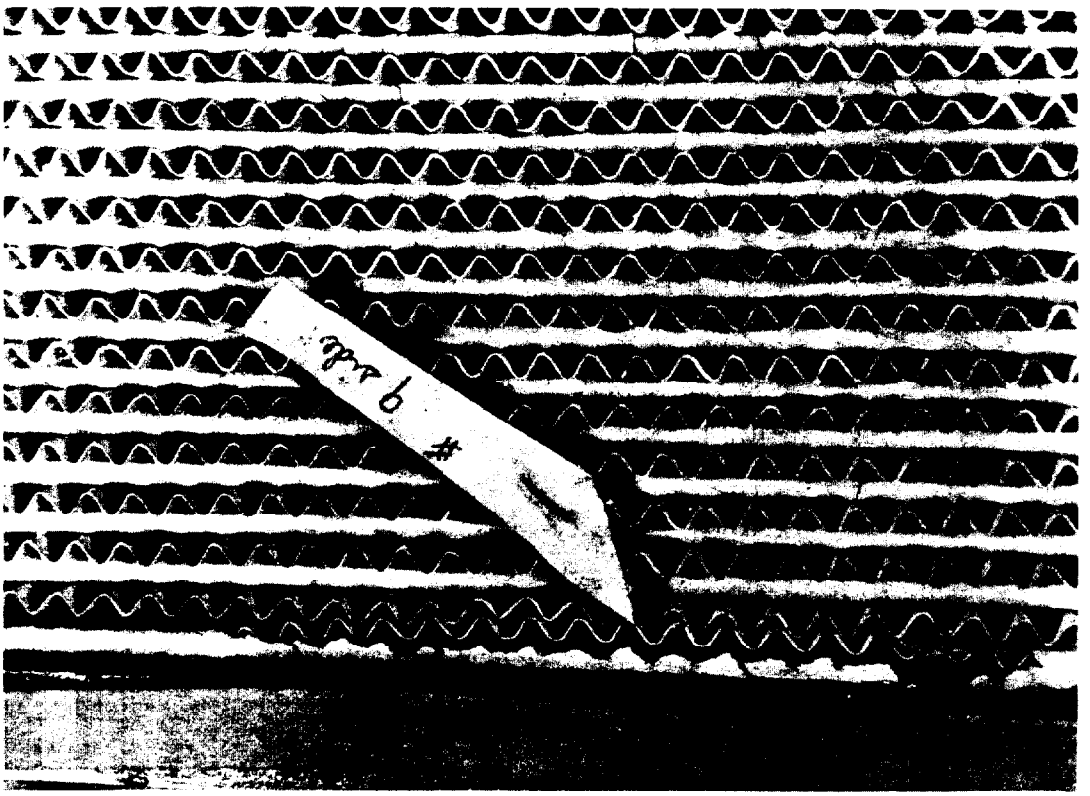
Slide 7



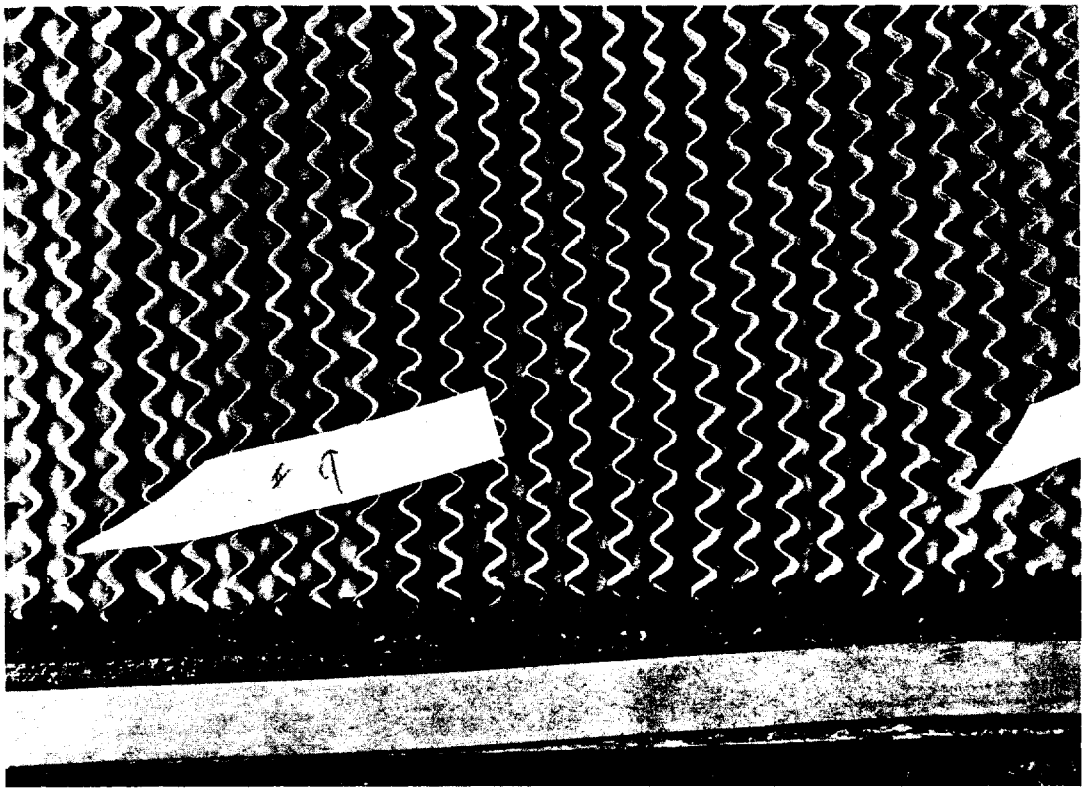
Slide 8



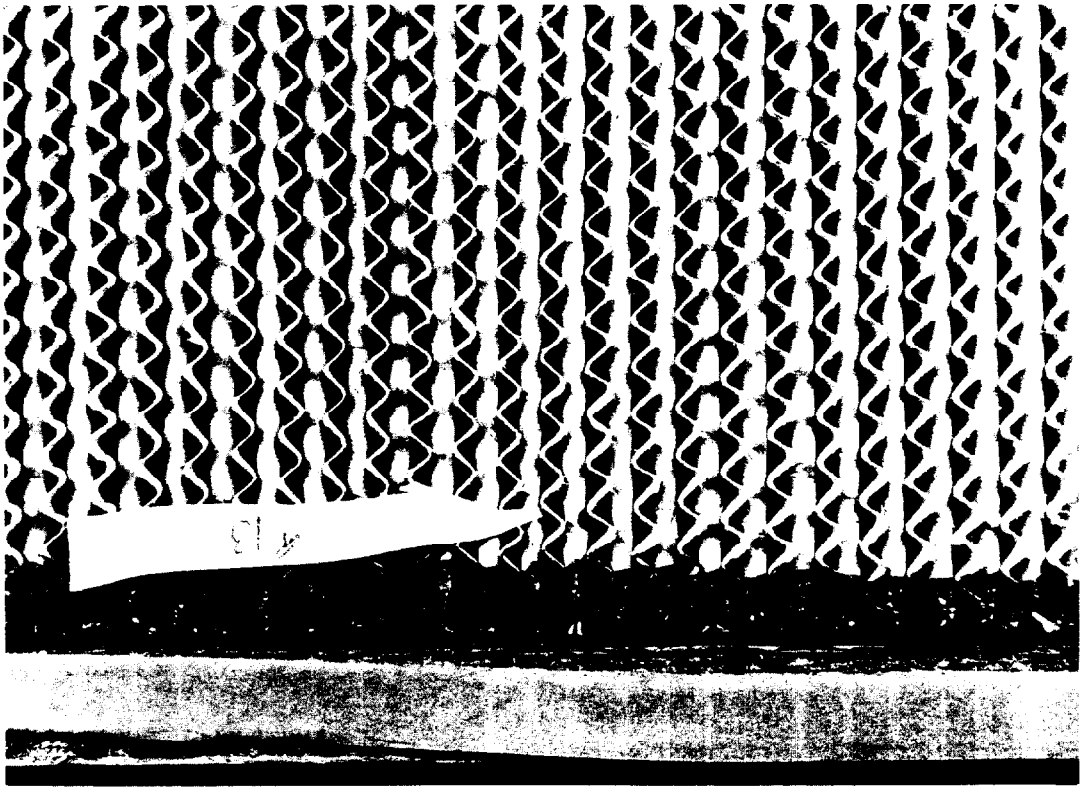
Slide 9



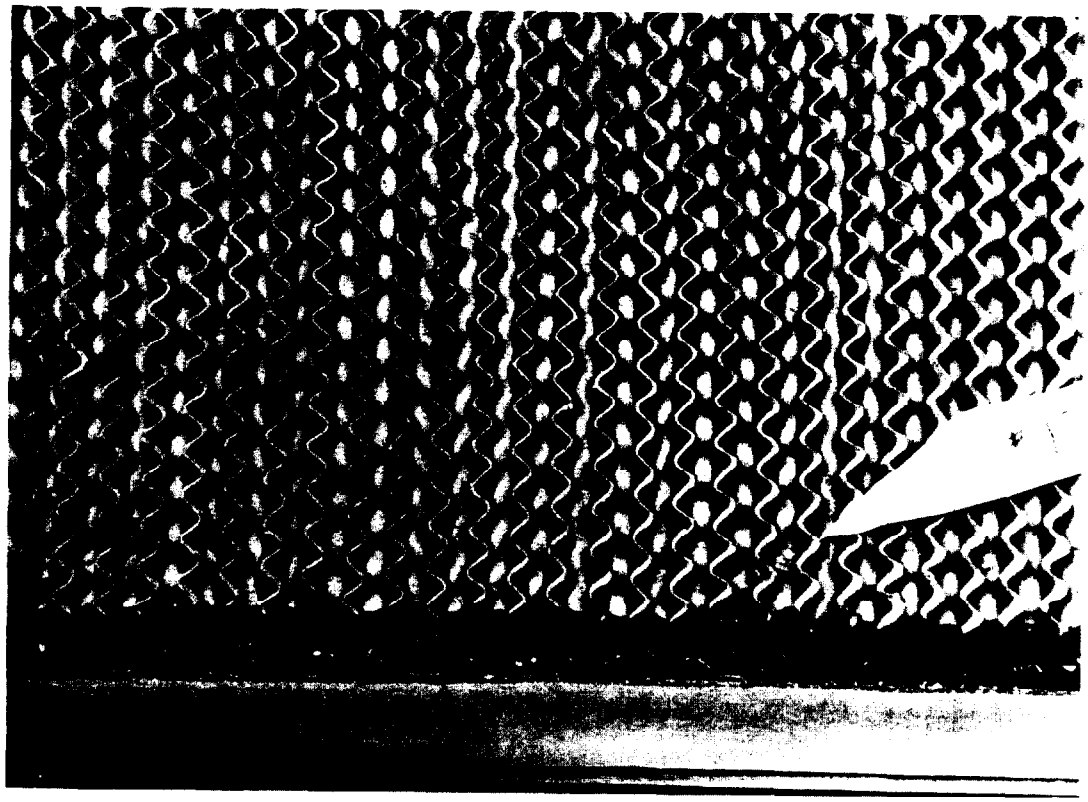
Slide 10



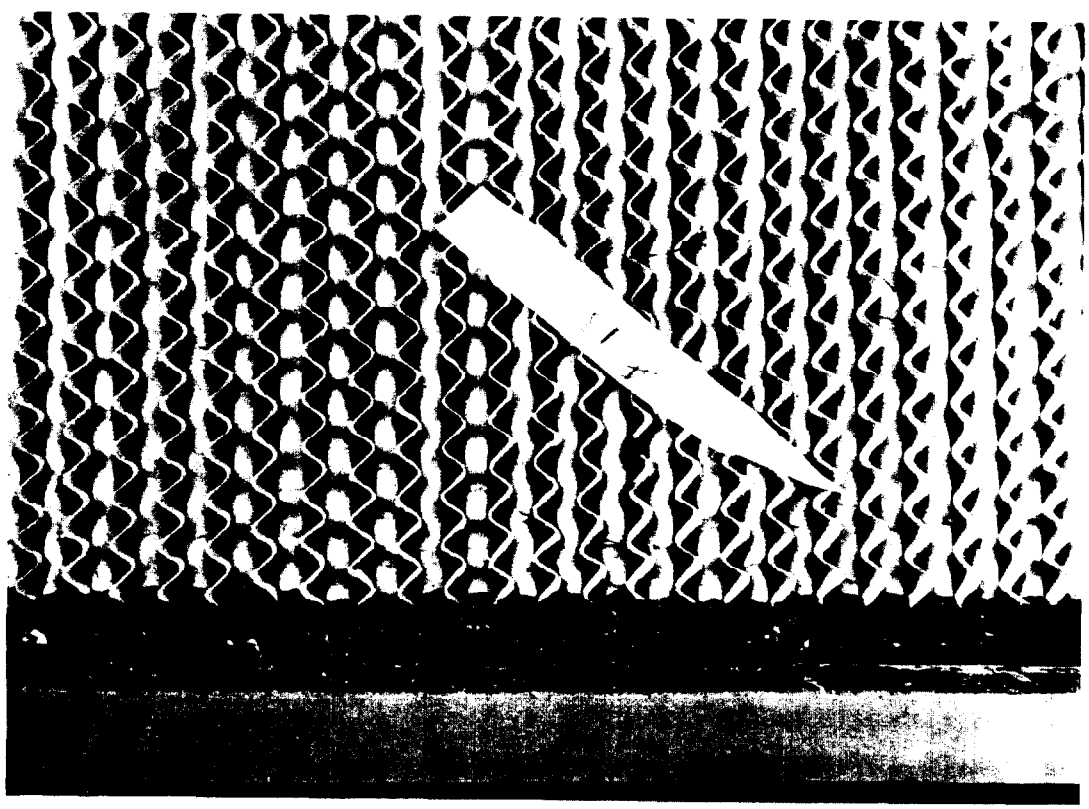
Slide 11



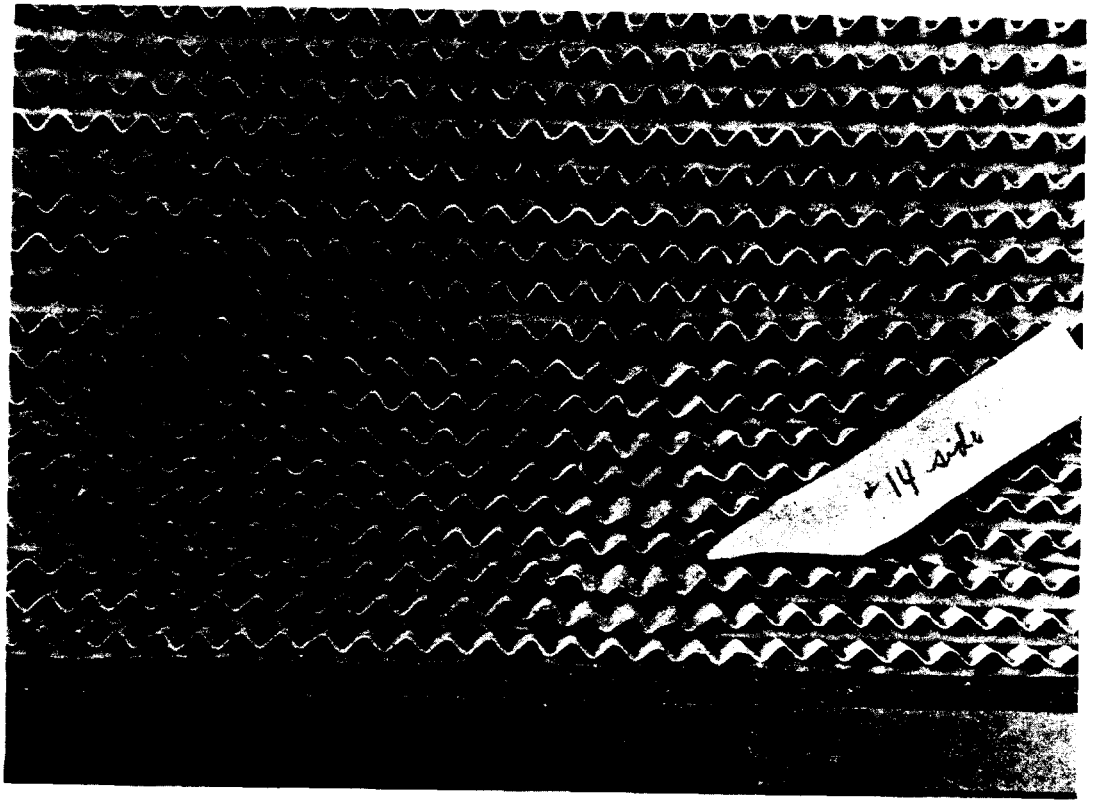
Slide 12



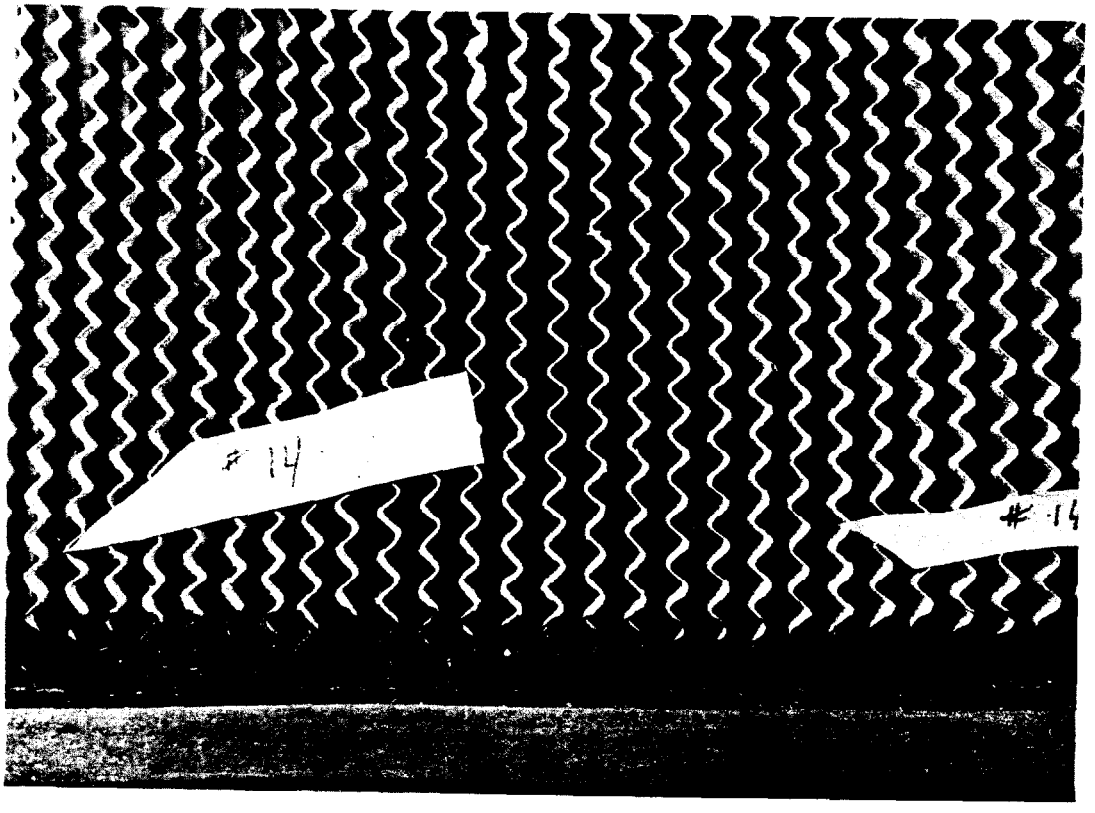
Slide 13



Slide 14



Slide 15



Slide 16

No. Samples	Penetration %		Resistance	
	Min	Max	Min	Max
240	.003	.024	.89	.97
222	.008	.024	.87	.98
118	.008	.024	.87	.97
120	.005	.023	.83	.98

These data were obtained from filters submitted for acceptance by the Chemical Corps inspector. The number of filters rejected by the contractor's own inspection and quality control activities is not known. From its experience with fabrication of filters, both in its arsenals and by contractors the Chemical Corps learned that, to obtain acceptable filters, we need definitive drawings and specifications, dependable test equipment, a good quality control program in the producing activity, and verification inspection by those having acceptance responsibility.

(Mr. Gilbert - continued)

Mr. Hurwitz has explained to you how seven of the twelve samples were defective. Needless to say, we reported to the plants from which we had obtained the defective filters and asked them to open all of their filters in stock to learn how many more were defective. Amusingly enough, one of the plants that had sent filters made by two different manufacturers contacted us and said, in effect: "We depend on stack monitoring to tell us when our filters are effective. Please advise which manufacturer's filters were bad so we will not have to open all of the cartons of filters that we have in stock."

Somewhat later we obtained additional samples from atomic energy stocks for testing. This time the samples were inspected thoroughly before they were shipped to the Army Chemical Center to complete the tests. The second batch was tested June 4, 1959. This is how the filters compared so far as penetration and resistance are concerned:

Slide 1. This shows comparative penetration readings on sample filters made by Manufacturer "X". The yellow background indicates the maximum penetration allowable according to the specification of

5 one-hundredths of 1% for dioctyl phthalate aerosol particles approximating 3 tenths of one micron in diameter. The blue bar on the left is the penetration rating placed on the filter by the manufacturer and so stamped on the filter frame. The red bar alongside the blue one is the penetration found by the Army Chemical Center. Notice that none of these samples made by Manufacturer "X" was outside the specification for penetration.

Slide 2. Here are the comparative resistance ratings on these same three filters made by Manufacturer "X". Again the yellow background is the specification limit, 9 tenths of one inch of water resistance. Likewise, the blue bar on the left is the manufacturer's rating of the filter's resistance and the red bar is the Army Chemical Center test finding. These filters by Manufacturer "X" also met the specification for resistance.

Slide 3. These are the samples made by Manufacturer "Y". You note that the manufacturer rated penetration of the first filter, on the left, at .05%, which is the maximum acceptable under the specification. Chemical Corps test rated the penetration at .076%. The second filter had stamped on it the manufacturer's penetration of .40% and while the Chemical Corps found it .25%, the filter obviously does not meet the specification. Incidentally, all of these three samples carried a certification by an inspector representing the atomic energy plant that purchased the filters. Needless to say, the middle filter should have been rejected by the inspector. The third filter was acceptable for penetration.

Slide 4. These same three filters made by Manufacturer "Y" were within the limit of 9 tenths of one inch resistance.

Slide 5. Of these four filters made by Manufacturer "Z", the first, on the left, had a penetration rating of .012% by the manufacturer. Chemical Corps test showed it to be .23%, considerably outside the .05%

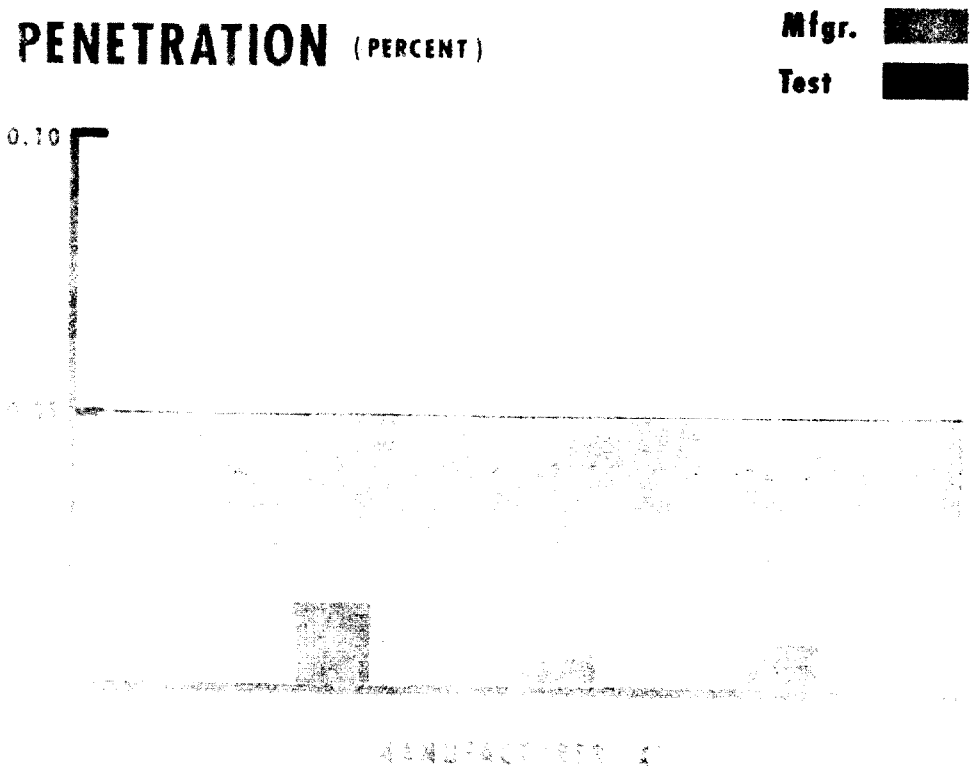
specification for penetration. The fourth filter, the one to the extreme right, had a manufacturer's rating of .008% and the Chemical Corps found it .056%, just outside the specification for penetration. The second and third filters, the two in the middle, met the specification.

Slide 6. Now let's examine these samples of Manufacturer "Z" for resistance. The first two, from the left, had the manufacturer's ratings to show that they meet the specification for resistance. Both, as you can see, exceeded one inch of water in resistance. For the two at the right, the manufacturer rated them at 1.10 inches and 1.00 inch resistance, respectively. The third was found to have .92 and the fourth .97 inch resistance. All four were over the limit for resistance.

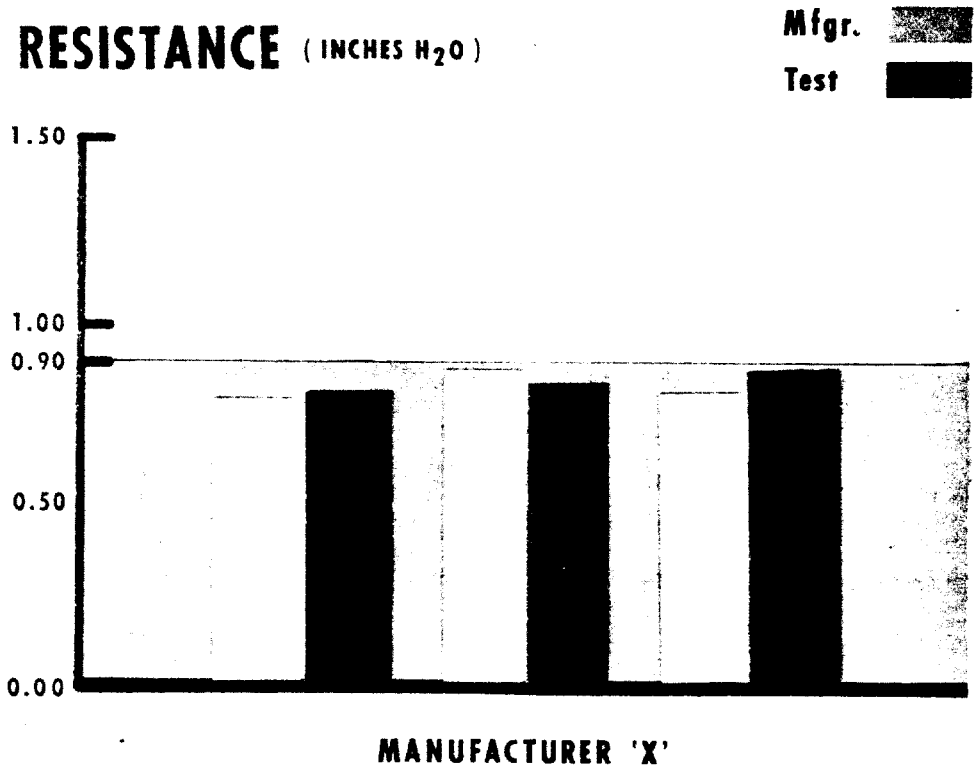
You have seen the defects that are being found in filters, which Mr. Hurwitz has described to you, and there is considerable evidence to indicate that these defects existed before the filters left the manufacturer's plant. Certainly filters can and have been damaged in shipment, however, these did not seem to be the case. Only two of a total of 18 filters sent by atomic energy plants to Army Chemical Center for testing had damage that could be attributed to handling or shipping after they were manufactured. You have also seen how these filters compared when verified on a DOP penetrometer other than the manufacturer's.

What course then shall we take?

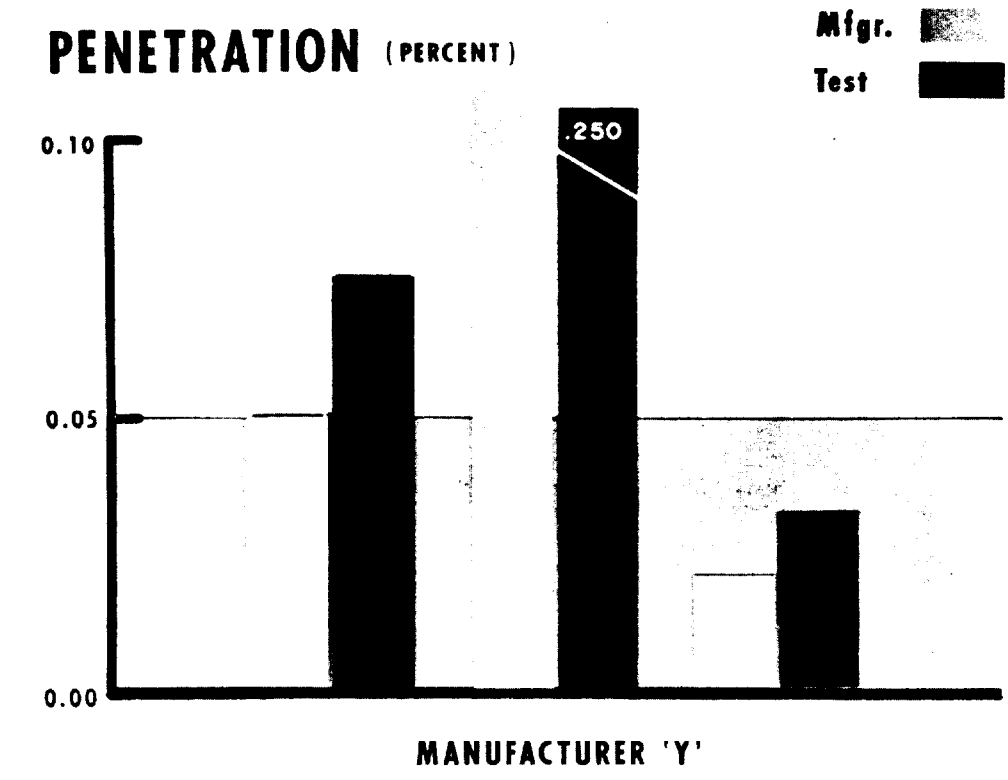
First, let's examine a basic point: Do we really need filters with the high degree of efficiency that is being specified? If we don't, then we are wasting money. We can buy filters with efficiencies of 70%, 80%, or 90%,on whatever particle size you select, at a price considerably less than we pay for these high efficiency filters Conversely, if we decide that we do need filters which are 99.95% efficient, then the time has come to make sure that we get what we are specifying. We have been negligent and, I suspect, a little naive, about the caliber of filters delivered to atomic energy installations. Just because we specify 5 one-hundredths of



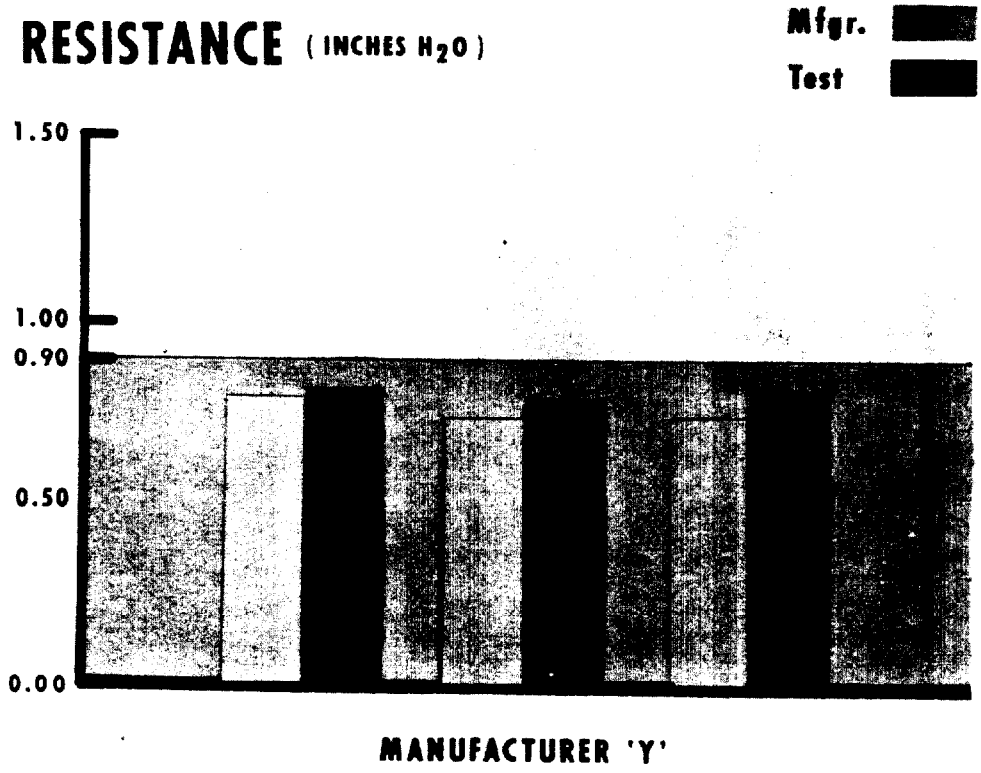
Slide 1



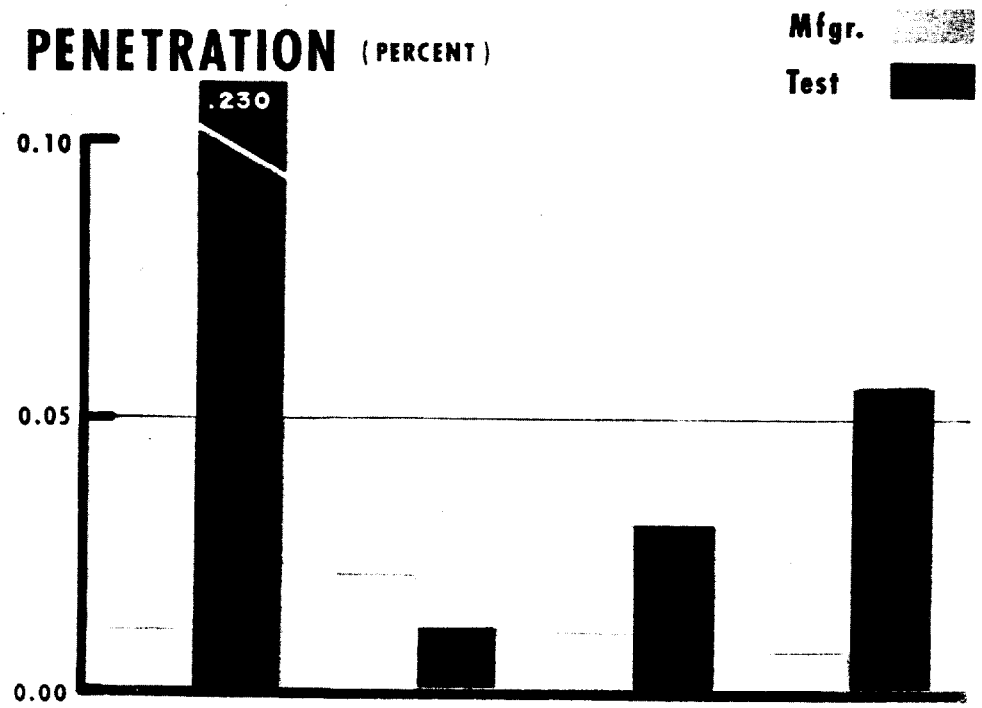
Slide 2



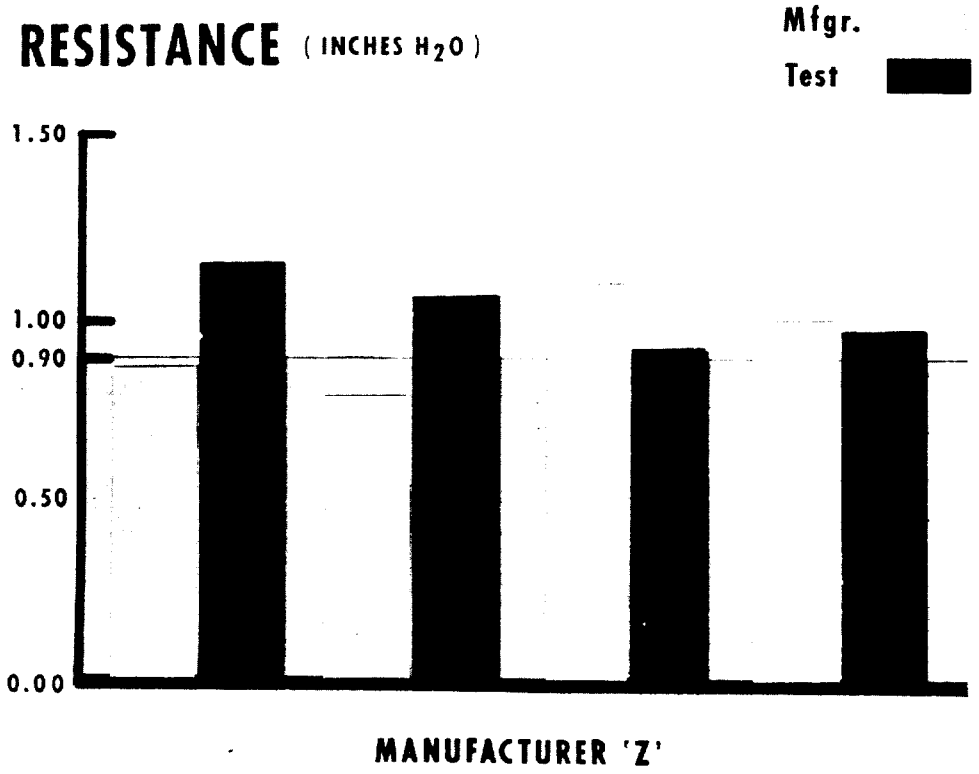
Slide 3



Slide 4



Slide 5



Slide 6

1% penetration and 9 tenths of an inch resistance is not automatic assurance that this is the quality of filter that will be delivered.

Now I recognize that you gentlemen representing the various establishments of the atomic energy program are not responsible for inspecting every filter delivered to your location. Nevertheless, I also recognize that you can be very influential in making certain that your plant accepts only those filters which meet the specification on which they are purchased.

Here are some suggestions: First, the purchase order for filters should specify that deliveries will be accepted subject to inspection and test. In this connection, we propose to revise the specification for fire resistive filters, contained in Issue No. 80 of AEC Accident and Fire Prevention Information, to include this suggestion. Copies of this issue are available here if, by chance, you have not received one.
Second, every filter received should be removed from its carton and inspected all over, including both faces, to assure that there are no holes or cracks in the media and no loss of seal or breaks in the adhesive. In addition, the filter should be true in shape, in dimension, and have good basic material in the frame.

Third, arrangements are now going on to install at Hanford two DOP penetrometers which will test filters of all sizes up to 1000 cfm. These machines will be available to check filters purchased by all atomic energy installations and the penetrometers will not be for Hanford's exclusive use. They are being installed at Hanford, rather than a more central geographical location, because there is every indication that Hanford will use many more filters than any other plant in the program. Consequently, it will be more economical to ship filters from other plants to Hanford, or from the manufacturer to Hanford for testing before delivery to you, rather than ship Hanford's filters to a more central point in the United States.
The AEC Safety Division at Richland, Washington, will be your point of contact for this testing service when arrangements are completed.

In addition to the penetrometers at Hanford, arrangements are being made with the Army Chemical Center to provide similar testing service. This will reduce transportation costs and expedite the testing for establishments nearer Edgewood, Maryland, than Hanford. When all of the details are worked out for penetrometer testing service at both places, the information will be circulated throughout the program.

Beyond the suggestions for inspecting and testing, the Underwriters' Laboratories is establishing an inspection and labeling procedure with the filter manufacturers to certify that high efficiency particulate filters which bear the UL label will be of fire resistive construction. This procedure also will help us to get filters of better quality, by discouraging the existence of holes and cracks such as Mr. Hurwitz showed you. The Underwriters' Laboratories'label, however, will not supersede each plant's responsibility to inspect the filter and to have it checked, independently of the manufacturer, for penetration and resistance. Mr. Leonard H. Horn of the Underwriters' Laboratories of Chicago is attending this Seminar. (Have Mr. Horn stand up and be identified). We have been working closely with Mr. Horn on this fire resistance problem and if any of you care to contact him outside these sessions, I am sure he will be willing to explain any aspect of the UL program. Whenever their program is put into effect, you probably will want to specify in your purchase orders that filters bear the UL label for fire resistive construction.

In conclusion, you must decide whether we need high efficiency filters or more economical filters with efficiences in the range of 70 to 90%. In some instances, these are what we are getting anyway although we are asking for high efficiency filters. If we do need high efficiency filters, then you must insist that filters, when delivered, be inspected visually independently and/tested for penetration and resistance to be sure that you are getting what you specify. We have notified all of the filter manufacturers

that we found defective filters in these tests and we have given each manufacturer the comparative penetration and resistance ratings on the samples which he manufactured. We have also put them on notice that, from here on in, we are going to inspect and test filters that come into the atomic energy program. I have had replies from all of them expressing their concern over the damaged filters we found, and it is difficult to believe that they would deliberately deliver defective and inefficient filters. Be that as it may, your efforts and the full impact of the influence of each and every one of you will be required at your plant or facility, if we are to keep bad filters out of the program. This is a condition that has existed too long in our air cleaning operations and you can help to correct it. Gentlemen, it is up to you.

THE INSTALLATION, HANDLING AND STORAGE OF HIGH EFFICIENCY FILTERS

W. J. RICHARDSON and J. H. PALMER
Chemical Processing Department, General Electric Company, Hanford, Wash.

Part I

The highly efficient filters of today require equally efficient installation methods and care as much as does the manufacturing of the units.

The high efficiency developed by these filters can be seriously impaired by poor or careless installation methods and improper handling. Storage can also be an important factor.

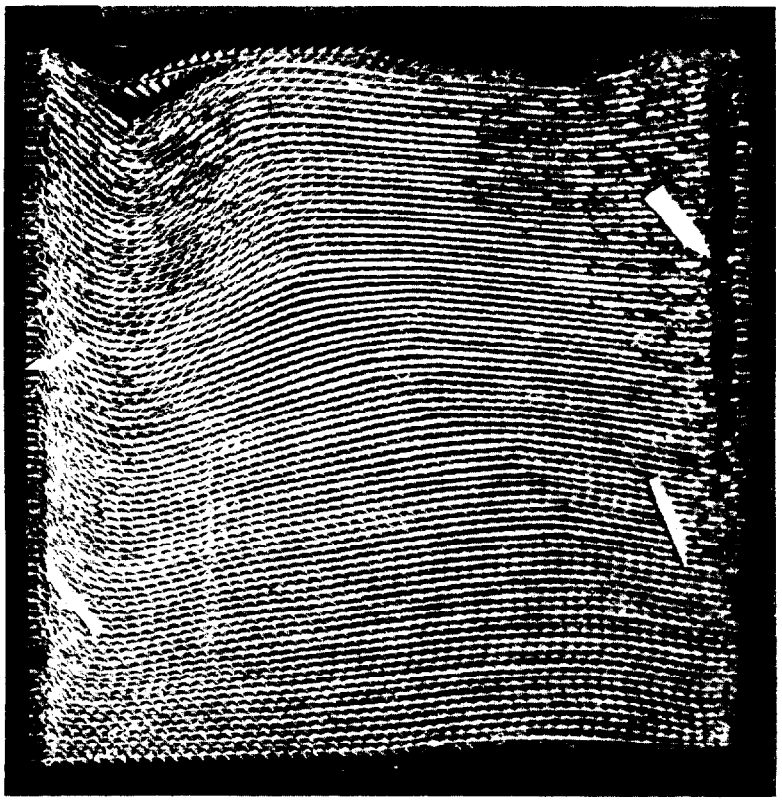
Thorough knowledge as to the construction of these filters should be acquired by all personnel involved in installation, handling, and storage. It has been found that many of the people who handle these filters have a misconception as to their construction. Some have the impression that the filter frame is packed with solid layers of media. With this impression, marred surfaces, split media, damaged separators, and holes in the filter face do not have any significance to them. The writer has often demonstrated the construction by means of cut-away models, usually followed by expressions of surprise by personnel, some of whom have been handling these filters for a considerable time.

The media, anywhere from 8 to 20 mils thick, is fragile and easily torn. When this is pointed out, the usual response is, "Why don't the manufacturers include perforated plates over the filter face?" This would be fine, except that it would be impossible to inspect the media for tears, or damage caused during shipment and/or handling at the factory.

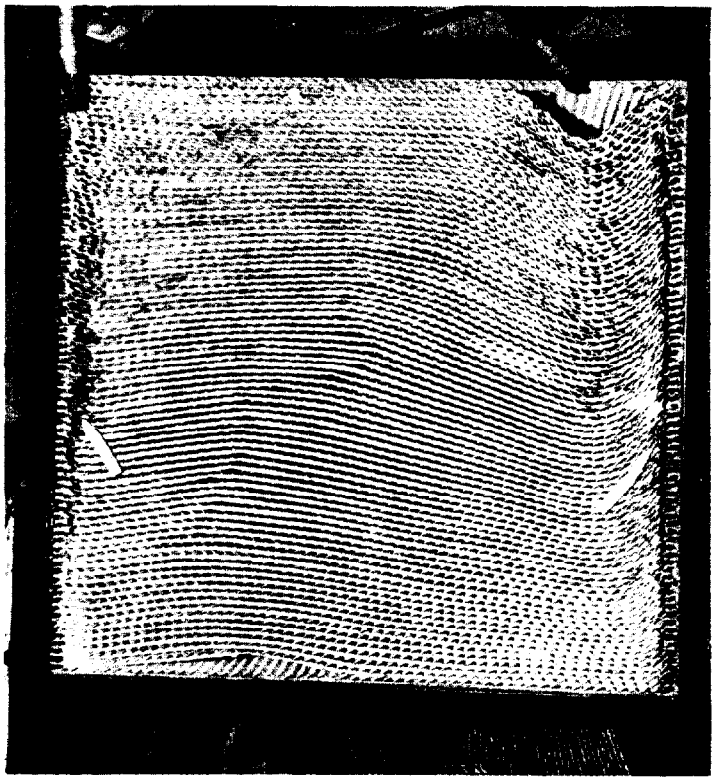
Perhaps the comment should be made at this time that damage, such as cracks in the media (especially along the sides of the frame), opening of the frame corners, and breaking away of the media from the adhesive does occur as a result of shipping and handling.

Pictures no's. 1, 2, 3, 4, 5, and 6.

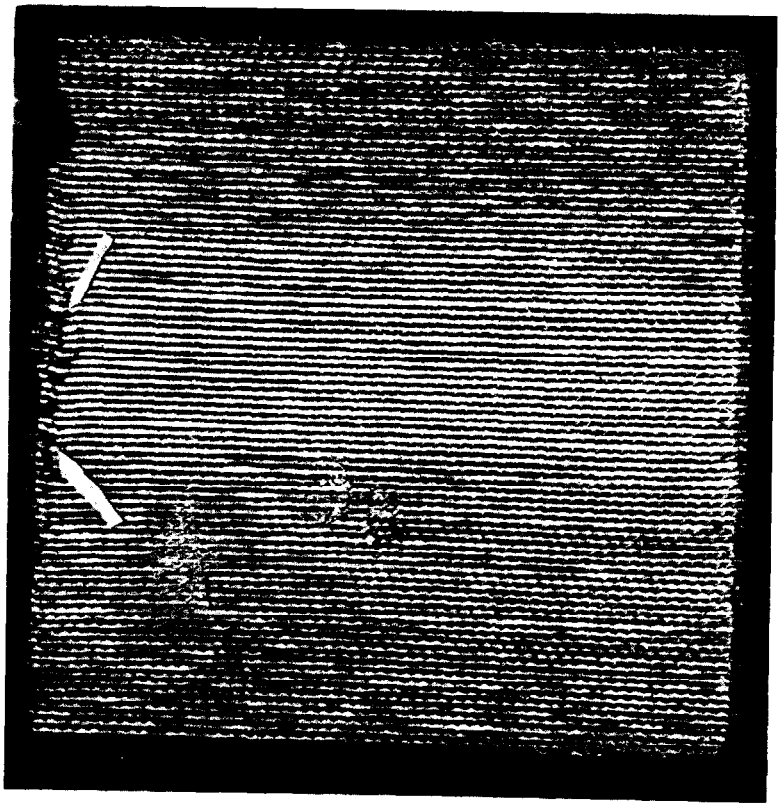
Sometimes the cause of damage can be determined by visible damage to the carton in which the filters are shipped, but not always. All filters should be inspected for the above mentioned faults as soon as received, so that they can be returned to the manufacturer, or so that shipping damage claims can be made.



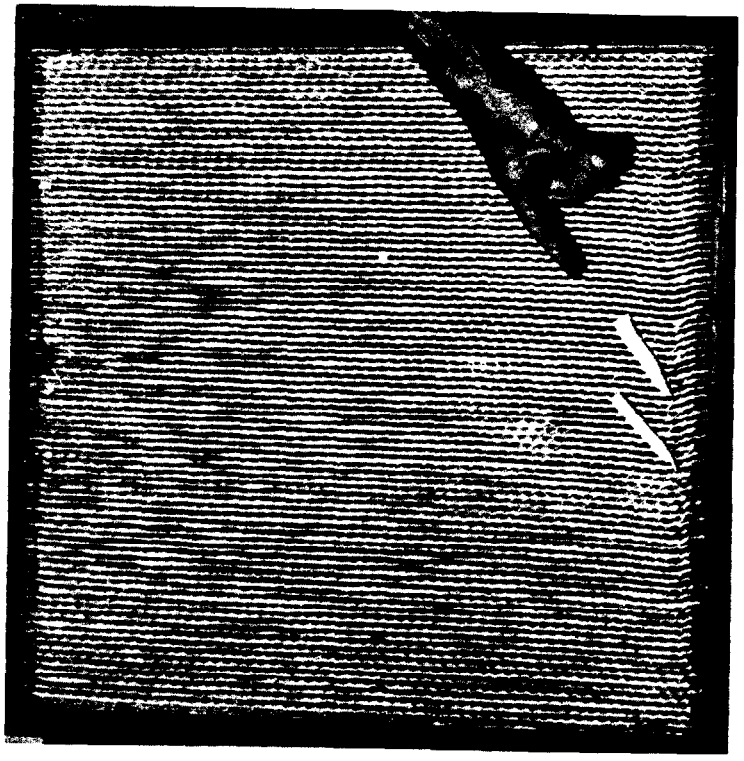
Picture No. 1—Filter damage. Note damage as a result of shipment. This is an unusual example.



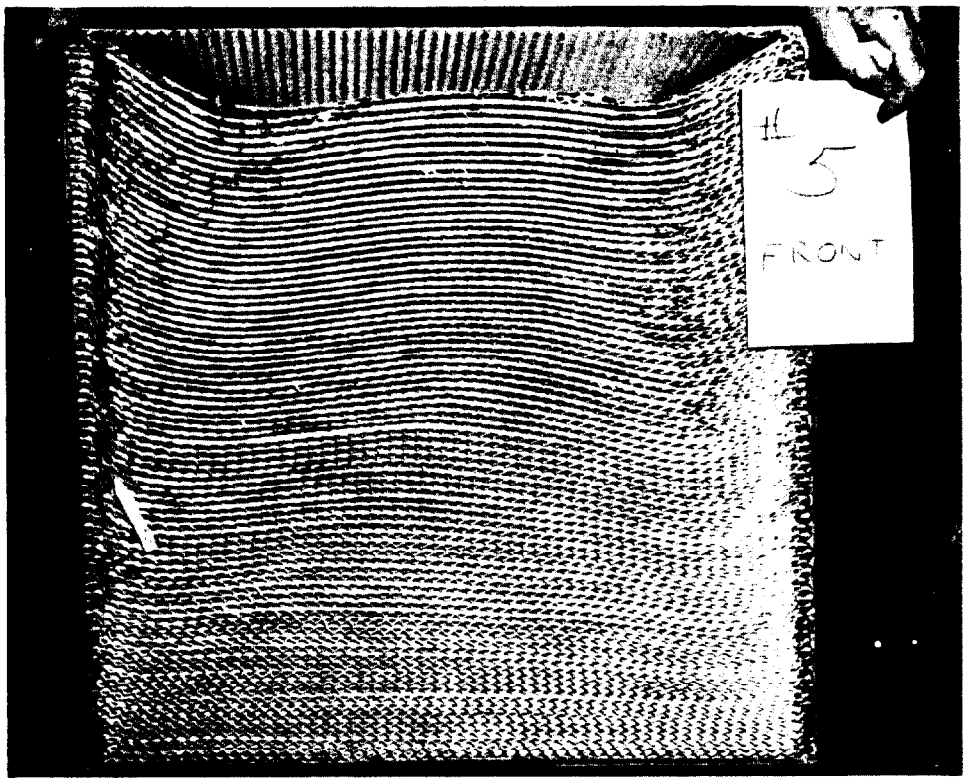
Picture No. 2—Filter damage. Opposite face of filter shown in Picture No. 1.



Picture No. 3—Filter damage. Filter media is cracked across top of filter. Separators are mashed. Mashed separators reduce capacity and life of the filter.



Picture No. 4—Filter damage. Filter media is broken in several places. Minor damage such as this is not too obvious to the uninformed and could be the cause of doubt as to efficiency of this type filter.



Picture No. 5—Filter damage. Another damaged filter. Container showed no external damage or corner bruises.

Picture No. 6—Gasket material. Note split in edge of gasket material.

INSTALLATION

Too much emphasis can not be placed on the importance of installation of the units. It is not too evident to the uninstructed mechanic, of the serious effect even a minor leak around the filter frame will have. Tests have been conducted at Hanford on the various methods of installation, in which the leakage rate was measured. Results were quite revealing and will be covered by my co-worker, Mr. W. J. Richardson, in a talk following this.

However, perhaps it should be pointed out at this time that even a one CFM leakage rate can be of serious concern when filtering highly contaminated air. For instance, it was found in one installation at Hanford, that a one CFM leak around a filter increased the down-stream count by a factor of two. This was on a new, clean filter. If the filter had been in service for some time with the consequent reduction of flow due to loading, the leakage could have been of greater significance.

The following instructions on installation of the space type high efficiency filters are, we believe, worthy of consideration:

1. The filter unit should be carefully removed from the carton, being careful not to drop the filter. (Jarring will sometimes cause the media and possibly the separators to crack at the place of contact with the adhesive.) Care should also be taken to not poke fingers through the media or damage the separators when removing the filter from the carton.

   If it is necessary to lay the filter with the back or face down when removed from the carton, care should be taken to be sure that bolts, nuts, stones, or uneven floor surfaces will not damage the media or separators. Remember - the filter is extremely susceptible to damage. Inspect the filter for cracks in the media and separators, and for separation from the frame.

2. See that the gasket is firmly cemented to the frame and that the gasket material is butted or meets at the joints and is itself undamaged. (Gaskets have been found with air-holes running through the sides of the material.)

3. If both gaskets are not needed for sealing purposes, the un-needed gasket should be removed and the edge of the filter frame cleaned at the points of clamp contact.

4. The surface to which the filter is applied must be true, clean, smooth, flat, and free of welds or weld spatter. It must be rigid enough to fully compress all the gasket surface, without warping or buckling the bearing surface.

5. The gasket should be firmly compressed, with the filter completely covering the opening.

6. The filters should be installed with the separators in the vertical position, to minimize sagging of media, when the filter is installed on edge.

7. In locations where the filter is subject to physical damage after installation, it should be protected by a wire mesh screen or expanded metal shield.

8. It will be noted that one face of the filter usually has a bead of adhesive on all four sides. The filter should be installed with this face towards the exhaust side of the ventilation system in order to minimize the possible

flow through the plywood joints of the frame of unfiltered air to the downstream. (These joints are usually tight, but when handling highly contaminated air, even a slight leak can be of significance.)

Various methods of filter installation will be described by Bill Richardson in his paper, following this.

FILTER REPLACEMENT

Filter units should be replaced under any one of the following conditions:

A. Pressure drop of 2" water gauge, or greater, across the filter.

B. Excessive build-up of lint, or product particles. (Fire and explosive hazard.)

C. Loss of efficiency as determined by air sampling measurements.

D. Visible damage or rupture of the filter media.

STORAGE

The filters should be stored where they will not be exposed to dampness, excessive heat or cold, or rapidly changing temperatures. They should be stacked no more than four high, with the separators in the vertical position as is usually indicated on the carton with a "This Side Up" sign or an arrow.

They should never be dropped, or thrown. The cartons should not be damaged in any way while handling. Hooks for handling cartons should never be used.

INSTALLATION, HANDLING, AND STORAGE OF HIGH EFFICIENCY FILTERS

Part II

I would like to take a few moments to explore just a little further into one of the several facets to which Mr. Palmer has referred in Part I of this discussion; this being the installation of high efficiency filters.

Those of you who are confronted daily with the problem of handling highly radio-active contaminants know that strict requirements are set by all AEC installations as to the amount of contaminants that can be safely emitted from any of the production or laboratory stacks.

You also know that in order to stay within these close tolerances you must obtain the most efficient filters on the market today.

Once the fact has been established as to the need of high efficiency filters for an installation, this would appear to alleviate all of our stack emission problems. However, as Mr. Palmer has stated, there are many pitfalls between the factory and the actual installation of these filters.

I would like to enumerate some of these pitfalls -

1. The filters must arrive at your plant site in good condition after being transported across the country.

2. All personnel handling the filters should be aware of the fact that these filters are actually delicate pieces of equipment.

3. Personnel responsible for the installation of the filters must provide a receiving framework that will permit maximum sealing of filters to the frame.

When you are certain that all of these conditions have been complied with, then, and only then, can you expect the optimum filtration for which these filters are designed.

I would like to relate a story concerning one of these pitfalls which occurred at one of our plants not long ago. Mr. Palmer offered his services to one of our production facilities to instruct their personnel on the proper methods of handling and installing high efficiency filters. The response received from this particular plant was, and I quote, "We have installed filters for years, we know all about them." It just so happened that Mr. Palmer and the writer had an opportunity to tour this plant a few weeks later. Being interested in filters, we naturally looked over their filter installations. Their primary filters are housed in stainless steel boxes with plexiglass ports for inspection and removal of filters. We were amazed to find numerous filters installed with the media on the front face torn or smashed in. Needless to say, these high efficiency filters were not performing as expected.

This attitude seems to be typical of plant operating people, who believe that the only thing that can happen to a filter is that it will "plug", or become loaded. They also seem to feel that as long as they replace the filters on a scheduled or predetermined basis, they will be assured of obtaining optimum filtration and that their responsibilities for clean atmospheric conditions end at installation.

They are of the opinion too, that small breaks or cracks, or leakage around gaskets is not of too much significance, as the leakage would be such a small percentage of the air being treated. This, of course, is entirely dependent upon the degree of contaminants held in the air being treated.

Our tests indicate that minor leaks are significant and that everyone responsible for installation of these units should be made aware of the consequence of such leakage.

How many of us can say we have personally, or at least have had qualified personnel, inspect these filters upon receipt at our plant site or just prior to actual installation? Also, have we inspected the construction of the rooms or boxes that are to house these filters?

We at HAPO asked ourselves these same questions and found that we were remiss in our responsibilities. As a result of this, we set up a test apparatus whereby we could simulate some of our actual methods of filter installation.

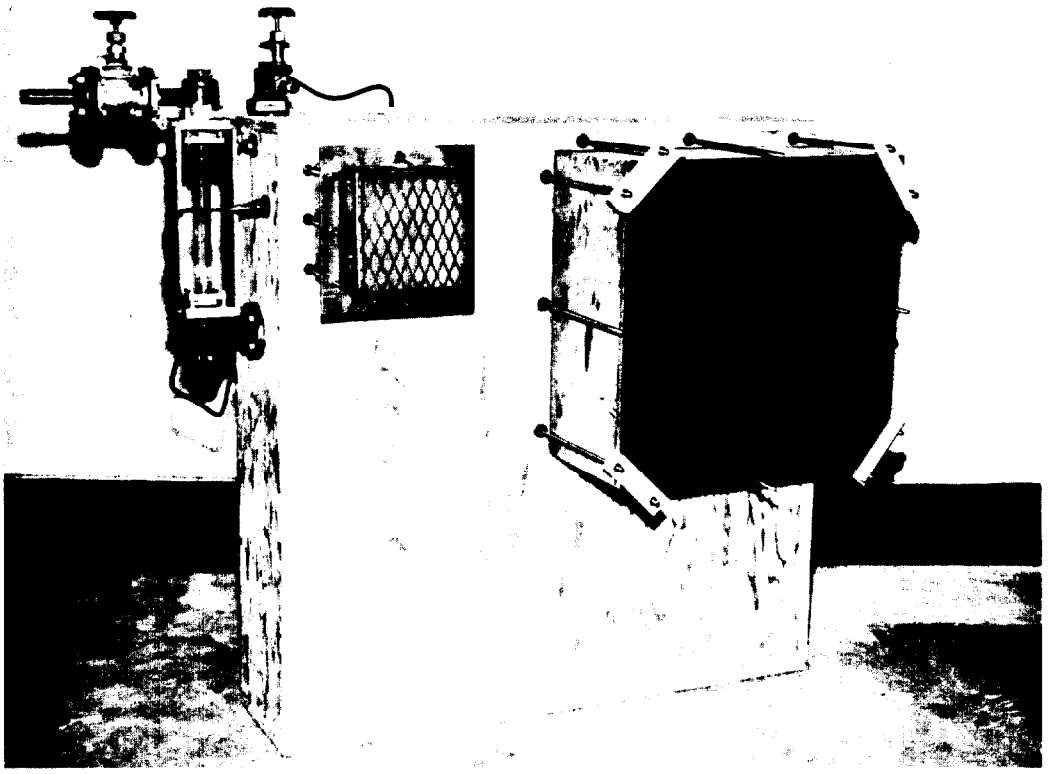
This merely consisted of a boxed chamber which would permit installation of both 8" x 8" and 24" x 24" filters.

The following slides will show some of the various methods of filter hold-down which are used in HAPO.

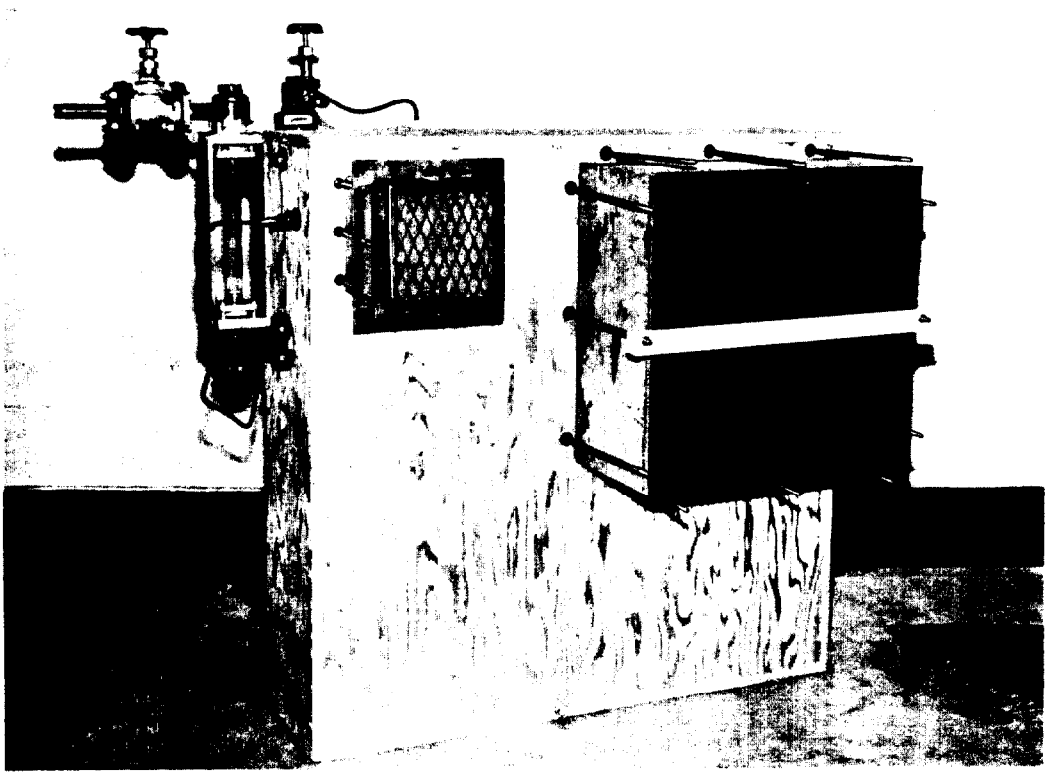
Picture 7 (Four corner hold down)
Picture 8 (One bar across middle)
Picture 9 (Two bars across filter)
Picture 10 (Three bars across filter)

Leak tests were conducted with these various hold-down methods on both the 8" x 8" and 24" x 24" filters to determine the amount of leakage around the filters.

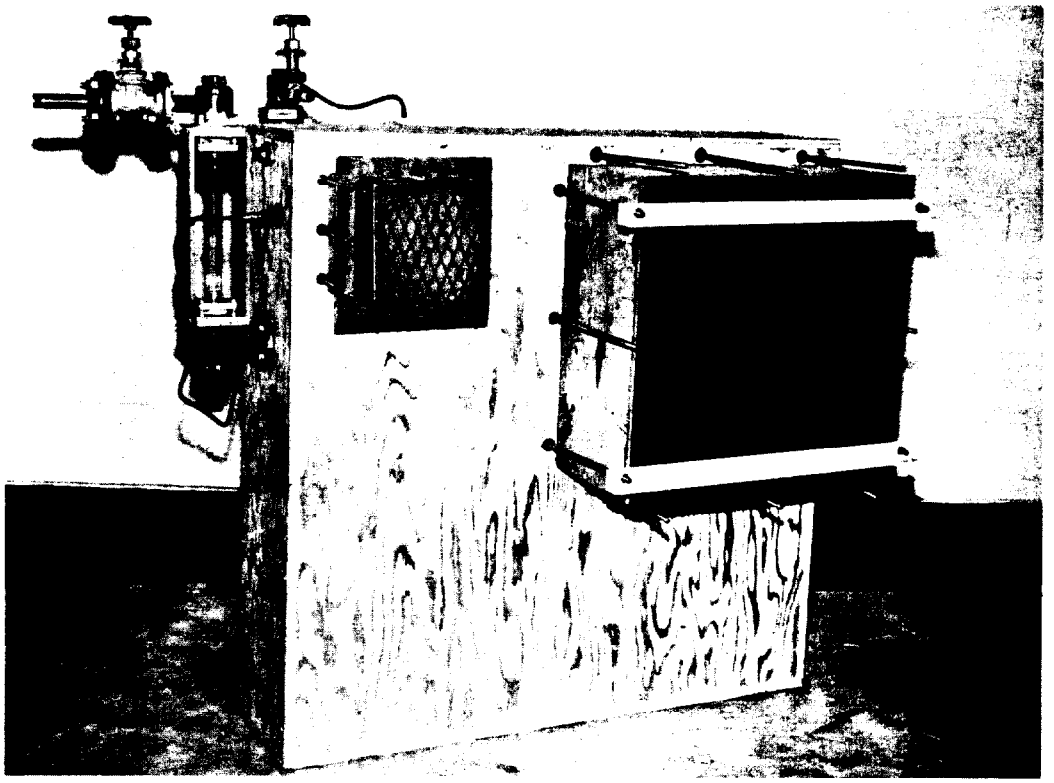
(Text continues on p. 195)



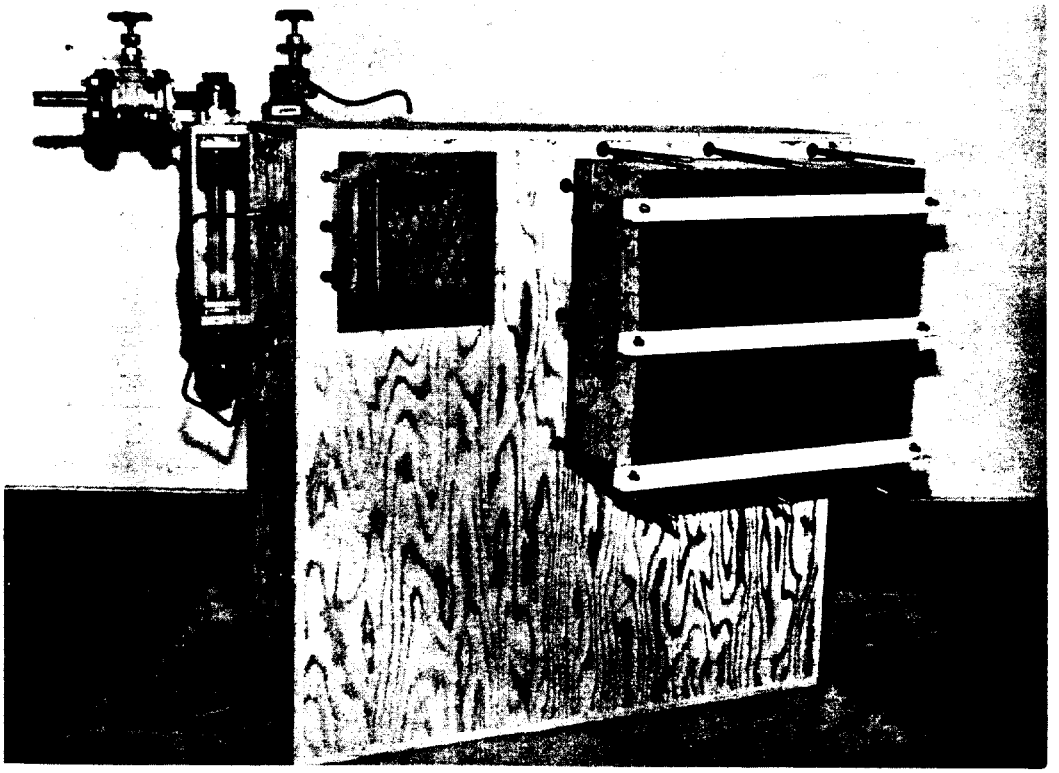
Picture No. 7—Gasket leak test. Four corner hold-down.



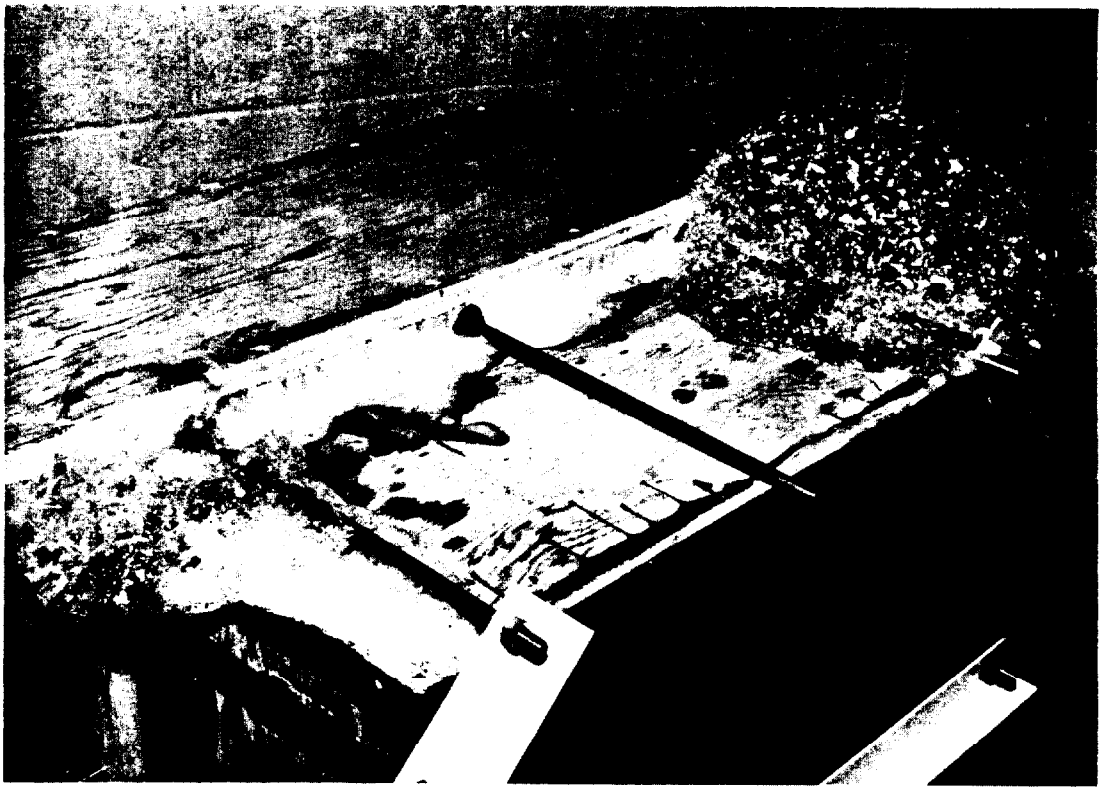
Picture No. 8—Gasket leak test. One bar across middle.



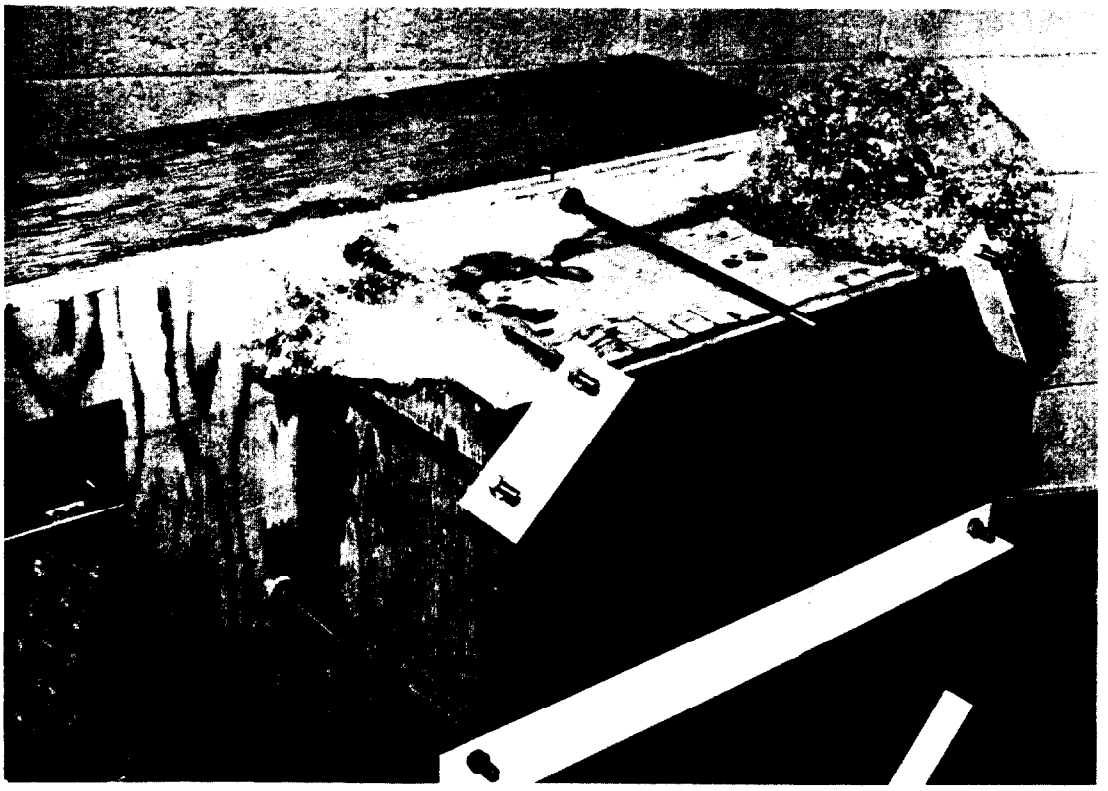
Picture No. 9—Gasket leak test. Two bars across filter.



Picture No. 10—Gasket leak test. Three bars across filter.

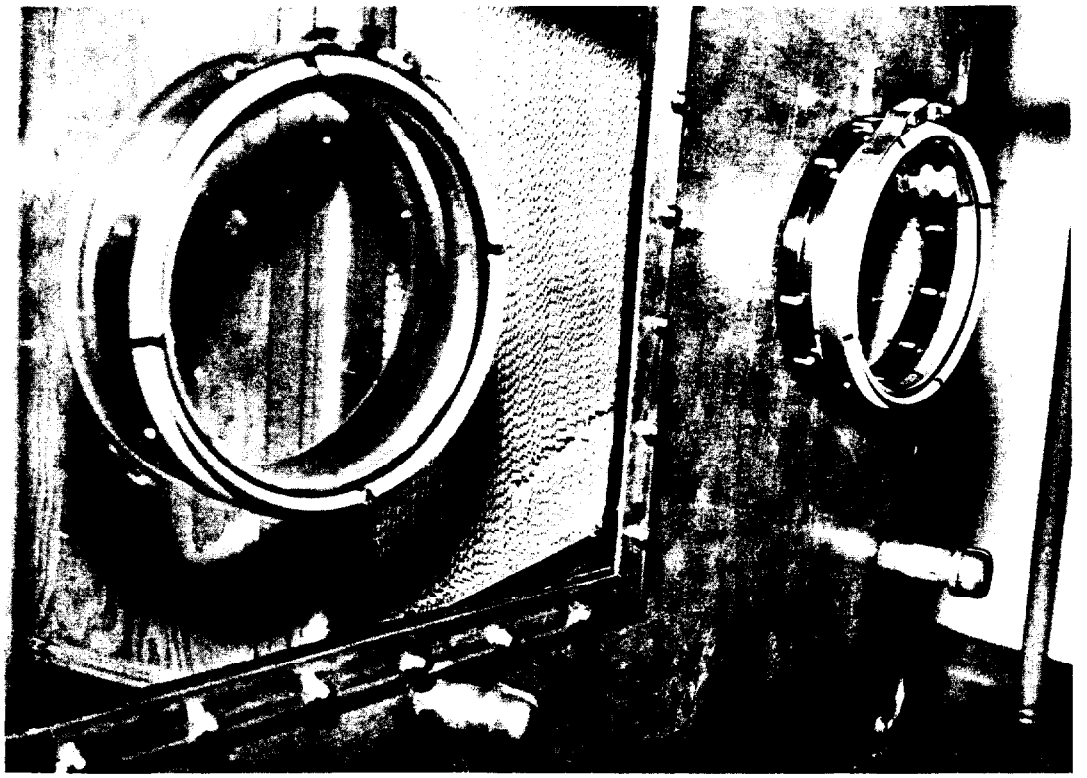


Picture No. 11—Gasket leak test. Test chamber under pressure. Soap solution used. Note leakage at frame joints.

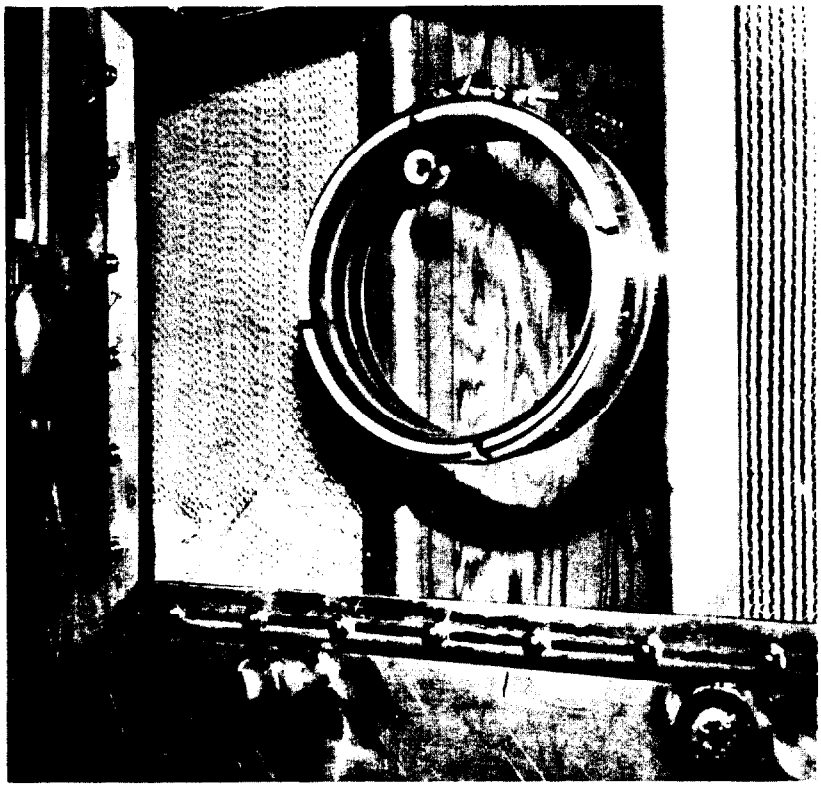


Picture No. 12—Gasket leak test. Note leakage at corners.

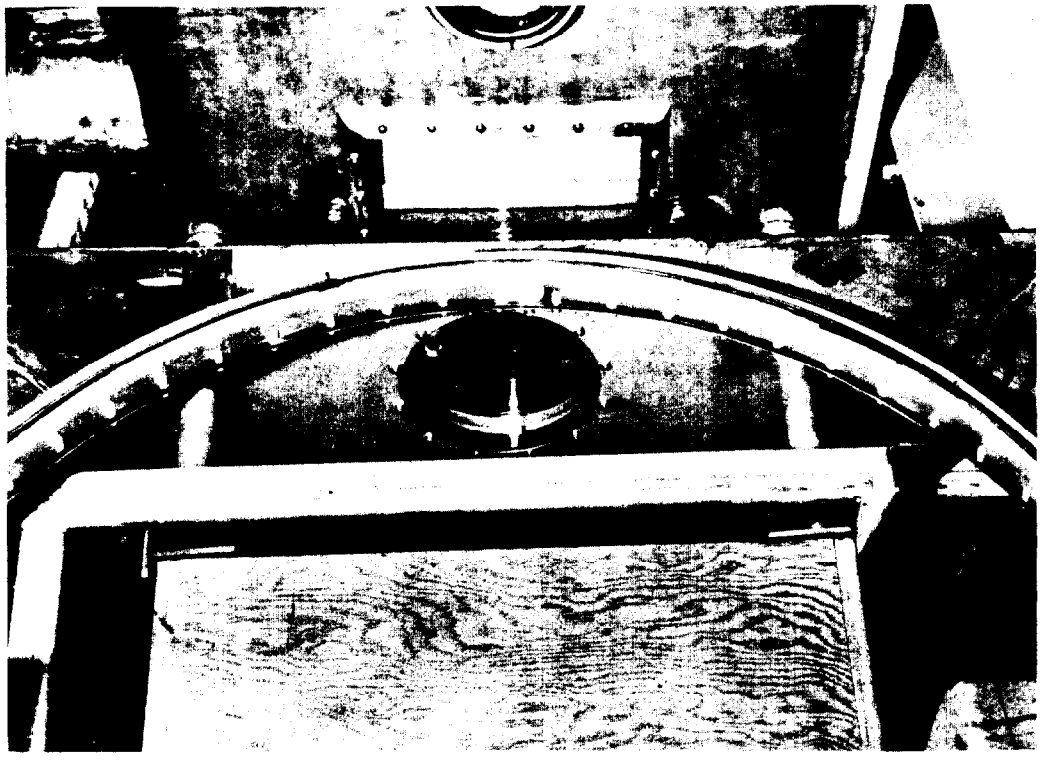
Picture No. 13—Gasket leak test. Note leakage at corners and at gasket. Gasket leakage is through pores of the gasket material.



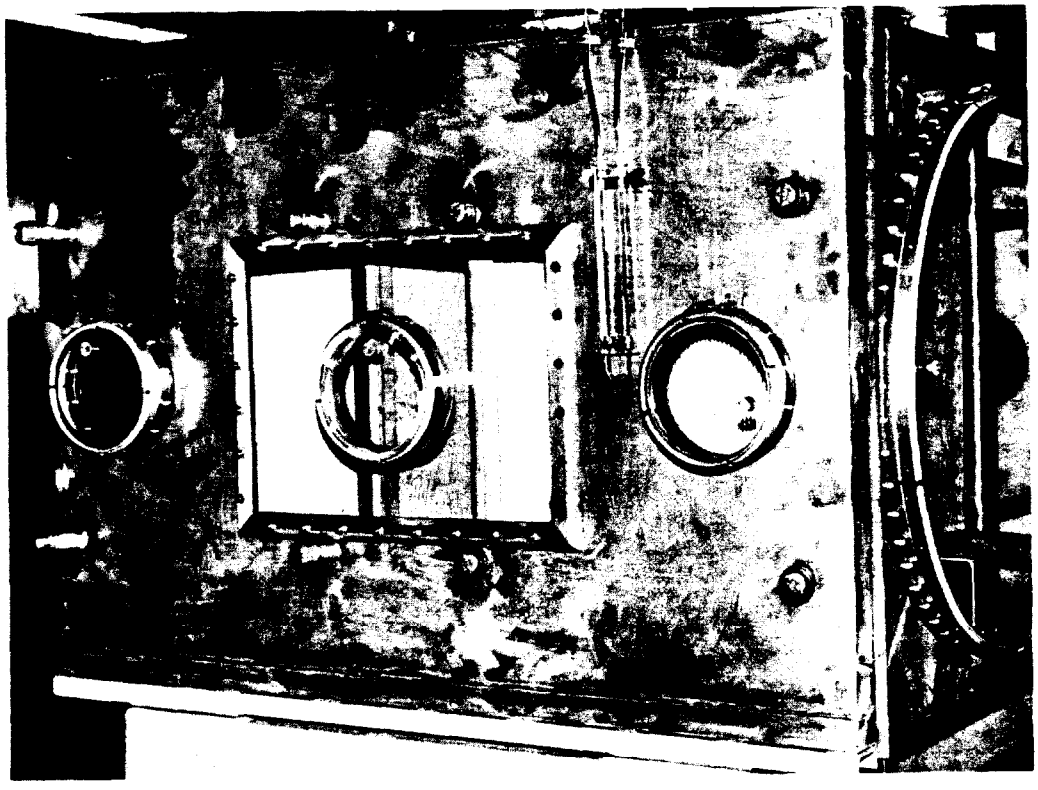
Picture No. 14—Filter installation. Actual installation. Note damaged filter. Media is broken through.



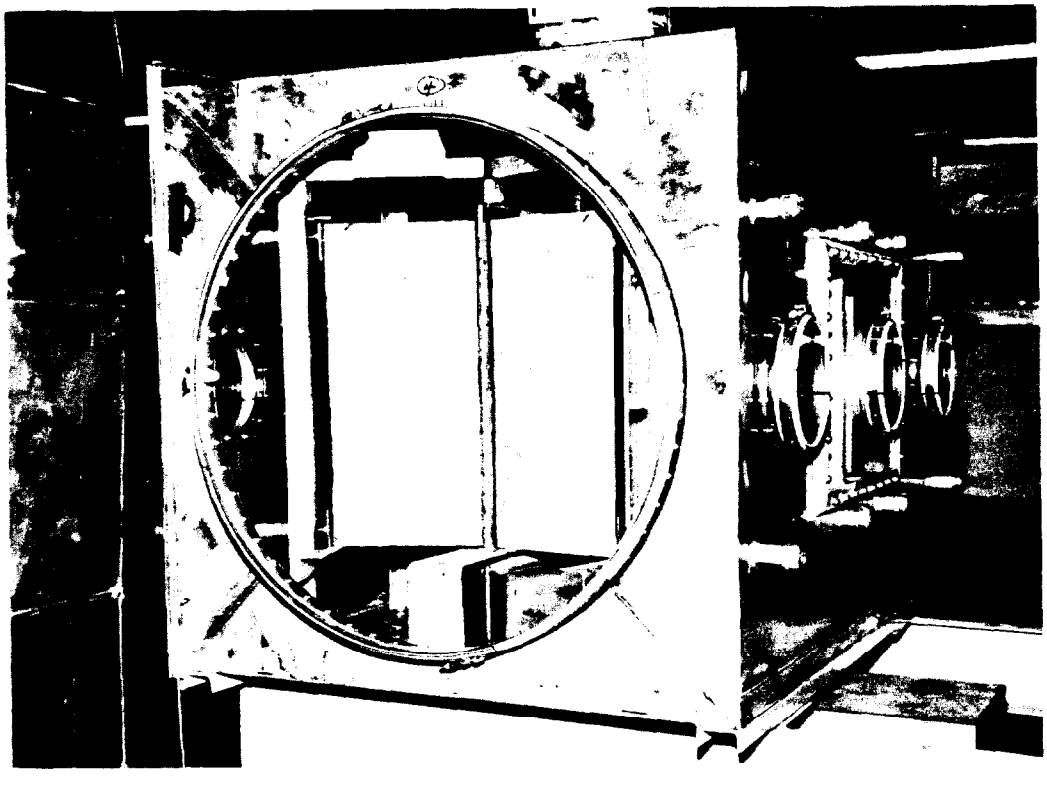
Picture No. 15—Filter installation. Same installation. Different filter. Note bruised separators. Media is punctured.



Picture No. 16—Filter installation. Note hold-down method. Hold-down bolts contact corner plates installed at filter frame corners and are manipulated from outside the filter box.



Picture No. 17—Filter installation. Filter box containing four filters. Heads of hold-down bolts are covered with pipe-caps.



Picture No. 18—Filter installation. Another view of the same filter box. Filters are installed at an angle, forming a diamond shaped center.

The 8" x 8" filter leakage was practically negligible with all methods of hold-down and from a 1" W.G. differential up to 6" W.G. differential.

The average leak rate on a 24" x 24" filter at normal differential pressure of 1" W.G. was ½ CFM. This increased to 1.5 CFM with a differential of 6" W.G. This leakage was primarily through the porous gasket material and especially where the strips of gasket material butted against each other. This leakage was constant with all types of hold-down as shown on slides, and made little difference whether hold-down bolts were finger tight or had a 5-pound torque applied. However, it must be pointed out that these tests were conducted with a perfectly smooth and aligned sealing surface for the filter.

Pictures no's. 11, 12, and 13 show results of soap tests.

The application of 25-foot pounds torque pressure at each corner of the filter frame was necessary to completely stop leakage through the gasket edges. This torque however, did not stop leakage at the frame joints.

Additional tests have been made and are still in progress whereby we purposely have built-in frame mis-alignment and warpage. One of the tests with a built-in 1/16" warpage showed leakage rates of 6 CFM or greater at normal differential of 1" W.G. This was with hold-down bolts finger tight. Once a 5-pound torque was applied to hold-down bolts, the leakage rate dropped off at normal of ½CFM at 1" W.G. differential.

Pictures no's. 14, 15, 16, 17, and 18 show a new type of installation adopted at HAPO.

When leak tests have been completed, the information will be available to all interested parties.

Discussion

Q. Are the army specifications for filters available to all for vibration test, etc., and might it be practical for some of us who are far away from the manufacturer depend on such specifications for quality not inherent in the filters we buy?

A. Material available for the asking. Package problem - certainly your carton can stand redesign. However, the Chemical Corps specs, except for overseas shipment only call for commercial pack. Took some down to discuss problem with packaging experts and they said yes they could fix a package up and make it as good as you want. Could even be a returnable package. We did receive three filters prior to shipping. Received in excellent condition. They were returned and apparently took rough handling in good shape.

What do you really need? Proud of Chemical Corps filter - filters treated with reverence--second only to their gas mask. To them it symbolizes the difference between living and not living. It's that simple - some of this should rub off on the installations handling fissionable material.

What media do you need? Thinks your people haven't actually determined what type of filter media you need. Thinks you have a great big research program ahead of you.

Q. Assuming you need a .05 penetration, would it be possible or practicable to have an AEC man who is in the general vicinity

of the manufacturer be present during the manufacture, fabrication, packaging, or whatever stage it might be to at least visually inspect the filters as they are manufactured to give some assurance that at least some with the large holes don't go into packaging.

A. (H. Gilbert - AEC, Washington) We run more of a staff than a service organization in Washington. Will arrange for what help we can get you. More contractors than able to cover adequately.

C. It is impractical for those on the West Coast to send representatives to the East Cost for inspection. It might be helpful to have an inspector.

C. (G. J. Hurwitz, Army Chemical Center) In the military we have inspection interchange whereby an inspector for the army can inspect material being purchased by the navy and vice versa. AEC would possibly come under the same regulation. There may be reimbursement in kind and there may not be. It is worthwhile looking into.

Q. (W. B. Harris - NYOO) When one has a job of air cleaning to do, it is reasonable to expect that the engineering department will look at the job and say how is it best to do it? Too many times we put in air cleaning which we think is reasonable for the job and then so we won't make a mistake, put more air cleaners behind it so if breakdown occurs we always have a high efficiency filter as a background. Thinks this is in many cases not necessary. Use of a space filter designed specifically as a space filter, either as a device to keep a command post clean or a tank has been applied to commercial air cleaning. Attempt to apply space filters to this type of application. Fire resistance in a filter is essential.

C. Another thing about the business of inspection - I think it is completely impractical to expect that any organization wants to order 6 filters; that these 6 will go from a manufacturer on the east coast to the laboratory in San Francisco and then be transshipped to Hanford, tested and shipped back again to Berkeley. It just doesn't make sense. If Hanford could be central purchasing agency and check filters, and if manufacturers understand their product was being spot-checked, quality would be improved considerably. Orders would go from this site to other sites. If no planned inspection is conceivable, this would certainly be an ideal situation.

Q. (J. F. Hall, United Kingdom) In connection with the licensees discussion on this - it will be interesting to see what our experience will be. We have the added safeguard on leaking gaskets and adjust - use canisters in all instances. Filter cartridge is put in and sealed up. It seems before you can have a common central inspection system you should have a common central specification. Much latitude exists. If people agree on things, why aren't they using them? I also heard you had a development on quartz paper.

A. (L. Silverman, Harvard) What you call quartz paper could be either - or fiber glass. Question of specs. is most important. Fibers based on insulation quality rather than filtration. Basic supply - who makes paper out of it may alter the supply. May have bad supply of paper for year and not know it. Differences show up due to manufacturers trying to cut costs. None

of the suppliers are making money - marginal operation. If these things are controlled at the source and specs. written, then quality control rests on workmanship. Perhaps other materials might be applicable today. Look forward, and this situation may push us into a little more development.

C. (Silverman) First I'd like to say that you get what you pay for in efficiency and requirements for various operations will depend on what the upstream loading is and what it is you want downstream. So it is pretty hard to generalize and say that 70% will do and 90% is too much. I think we are now agreed that there is a safety factor in using.05% penetration and we apply it across the board. Part of our economic survey which Joe Fitzgerald will talk about tomorrow is aimed at finding out whether you are getting your money's worth efficiency wise, for your air cleaning dollar. There are many operations where low ratings would only require 70% filter. But there are many others where the activity of the material at low loading is so high that you have to use 99.95. So much then for requirement. It seems to me that a lot of this problem as it now exists has cropped up from the fire problem. We didn't have, as far as I know, this efficiency and filter rupture problem with the paper filters. I don't recall any of this and we at Harvard have done a lot of blasting of the paper filters under the shock wave test. We also tested under shock wave some of early glass ones but not of the more recent fire resisting construction. We also took both paper and glass filters out to Nevada for our shock test and we had, I think, two dozen filters out there at two points from the weapons tests we ran in Nevada. So I think that this problem has not been with us for the last ten years or if we are, Brookhaven has been filtering at a poor rate with their nine year old filters. I do think Lee Gemmell can confirm this. In fact, they have some that have been in operation at least five years and maybe longer, of the paper type. I knew of several that have been in for 4½ years. I guess Dow Chemical had the 4½ year ones, that went up in a hurry. So I think a lot of the problem is of recent origin and I think it is high time that we checked it now. The specifications that are required aren't so much for testing of filters. This is what concerns me. I think we may be trying to attack this Goliath with forks instead of with really good weapons. That is, to get back and find out if there is a material failure or whether it is the wrong material that is being used now or whether the cements are improper, and the specs used for the plywood are improper. It is true that the assembly and the Quality Control should be put into the specification but if they are going to have to test every one of these filters routinely it is going to run the cost of them way up and I think we have got to get back to the source of the defects. I cannot believe that it is all one of these random sort of things, and, that it will be in a given production, it might be the cement at one end and/or the other. I think there is something fundamental here that is faulty.

C. (Keigher, AEC Hanford) I think we should get back to the fire re-resistant aspect of this just a little bit. We are not going back to a combustible filter as far as I can see. We have had some fifty recorded fires in combustible filters in the Atomic Energy program already - like the one we had in the air cleaning lab that cost $10,000 - in Rocky Flats and in many other places. I feel that I should defend the fire resistant filter because I attended the air cleaning seminar at Argonne and they presented

us with a challenge. We have always felt it should have the fire resistenceness or the non-combustibility and the same time the equivalent or better of the filtering media. I think that there has been a change, Mr. Silverman has referred to this, since they developed an A. D. Little paper in 1951, when they went towards the all glass and the glass asbestos media. This media apparently was an acceptable filtering media at the time it was made and I think those of us who are interested in the fire aspect of it expect the present media to be as good. Whether there were cracks in those days or not I don't know. I am convinced however, that just as we found there were never any fires in the CWS filters during the MED date, most of this was because of very poor reports. There were fires I found out but you can't find them recorded anywhere. I think breakthroughs could have occurred in those days but everyone was too busy winning a war to go into where this was happening and why and so forth. Now we have a chance to get into some of these finer aspects if you wish. The disposable and combustible filter has existed in industry. The New York Eastman Kodak had a $3\frac{1}{2}$ million fire in November of 1950, in bag filters. The fact is that the fires in ventilation systems and filter banks are one of the major classifications of fire losses in American industry. I say all these things only to, let's not say it's impossible because it got into the fire resistant filters. This, I think, is a correlation here. But let's not go backward in this aspect. In manufacture of filters, we have to help manufacturer discover what is the matter. Find out what is wrong and fix it now. Someone should carry this matter to conclusion and AEC, Washington should be the one to do it.

C.- I'm afraid many of us have missed the major points. I feel that we don't want to go back to cellulose asbestos filters. But something in the manufacture of filters that are put out by all the people is wrong. I feel that we have to help these manufacturers find what is wrong. We have to find out what is wrong with these filters and fix it now.

C.-It would appear to my humble judgement that the Division of Reactor Development and the Harvard Air Cleaning Laboratory have been called upon to get their heads together - the move must come from them. The contractors as a group are almost helpless except for little things like visual inspection.